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ABSTRACT

This document describes 10 examples of innovative and outstanding science/technology/society (STS) programs. These programs were selected using state criteria and at least four independent reviewers. While Project Synthesis offered a desired state, these examples of excellence provided views of what is already a reality. The goals of an exemplary science program are provided along with the criteria for excellence. The programs described are: (1) "Unified Science Modules"; (2) "Solar Project Class"; (3) "Environmental Science"; (4) "Energy and Us"; (5) "Mankind: A Biological and Social View"; (6) "Wallingford Auditing Technical Team"; (7) "Science/Mathematics/Computer Magnet School"; (8) "Contemporary Issues in Science"; (9) "Earthscope"; and (10) "Marine Environmental Program." Also included are a critique on STS and a paper on teaching STS in secondary school. (KR)

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FOCUS ON EXCELLENCE

Volume 1 Number 5

SCIENCE/TECHNOLOGY/SOCIETY

Edited by

John E. Penick
and
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Science as Inquiry
Elementary Science
Biology
Physical Science
Science/Technology/Society

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Teachers in Exemplary Programs: How Do They Compare?
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PROLOGUE: SEEKING EXCELLENT S/T/S PROGRAMS

By

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Many descriptions of excellent ideas, activities, and complete science programs have been published, read, and reviewed; resulting in considerable improvement in science teaching and additional recognition of continuing problems. With this first volume of the **Focus on Excellence** monograph series, The National Science Teachers Association hopes to provide a source of inspiration, ideas, and resources as well as descriptions of innovative and successful practices. The nine Science/Technology/Society programs described in this monograph are certainly innovative, successful, and inspirational.

For 1982, our search has been for outstanding programs in five focus areas; Biology, Elementary Science, Science as Inquiry, Physical Science, and Science/Technology/Society. For each area, we are devoting a monograph such as this describing innovative programs with a particular focus. This continuing monograph series from NSTA will highlight excellence in Middle School/Junior High Science, Physics, and Informal Science Education in Volume II. Future years will see a search for excellence in other school science areas, teacher education programs, and other aspects of science education. We feel strongly that this monograph series, **Focus on Excellence**, will play a needed and vital role in shaping science education practices and research of the future.

The 1982 Search For Excellence in Science Education began when Robert Yager, NSTA president for 1982-83, was invited to become a member of Project Synthesis. The perceived need for Project Synthesis came in 1976 when several National Science Foundation funded studies revealed the current state of science education in the United States. Then, in 1978, a synthesis of the more than 2,000 pages of information from those three NSF reports and from the National Assessment of Education Progress data was begun by twenty-three science educators throughout the United States.

The Synthesis researchers worked independently in small teams, each focusing on one aspect of science education; Elementary Science, Biology, Physical Science, Science/Technology/ Society, or Inquiry. A critical part of the synthesis analysis was developing a description of an ideal or desired state for a focus area and then comparing the actual to the desired state. During the Search for Excellence, goals arising from the synthesis desired state for each of the five focus areas were used as criteria for defining excellence in a school science program.

Leading science educators (generally state science consultants) in each state were identified as chairs of committees to identify and nominate outstanding science programs in their respective states. Ultimately, 165 state nominations were submitted to the project director for consideration at the national level for 1982. Thus, the state exemplars were passed on to another set of review committees and yet another selection process.

To aid in the selection process, all nominees were asked to fill out forms detailing information on demographics, texts used, and the nature of the school. A questionnaire, developed from the desired state criteria, was completed by the nominee as an integral part of the nomination packet. In addition, the state nominees were given the major criteria for excellence and asked to provide narrative information about five aspects of their programs.

* Provide some information about the setting (community location, size, specific features, school science and organization);

* Describe the nature of the exemplary program (grade, level, class sizes, curriculum outline, learning activities, evaluation techniques);

* How does the program exemplify the 1982 criteria for SESE (Abbreviated criteria were made available and reference to Volume 3 of NSTA's What Research Says to the Science Teacher was given);

* How the exemplary program came into existence

* What factors contribute to the success of the program and what is needed to keep it going?

Nominations were divided into five groups; Biology, Physical Science, Science/Technology/Society, Inquiry, and Elementary Science. Each group was then reviewed by different teams with at least one of the original synthesis researchers on each team. Each program was compared to the desired state criteria and reviewed by at least four independent reviewers with reviewer discussion usually leading to a clear identification of the national exemplars in each focus area. These National Exemplars numbered twelve in Elementary Science, seven in Physical Science, and ten each in Biology, Science/ Technology/Society, and Inquiry. A separate monograph for each 1982 focus area is available from NSTA.

While Project Synthesis offered a desired state, these examples of excellence provide vivid views of what is already a reality. We hope you can profit through reading these descriptions by finding inspiration and a source of ideas. The programs described range in size from small schools to large, represent both urban and rural populations, and include elementary and secondary schools from a broad geographical range. Schools with exemplary STS programs are found in communities of 1000 to those with more than 200,000. Size of school or community does not seem to be a limiting factor in achieving excellence. Some schools have large budgets while others have almost no money at all.

Grade level is not a factor either. STS seems to work well regardless of the age of students. Not surprisingly, teachers are the most significant factor. Teachers in all of these programs are dynamic, thoughtful, young at heart, and eager to learn with their students. (If you are interested, see another monograph from NSTA, **Teachers in Exemplary Programs: How Do They Compare?)**

Chapter One describes **a new view for STS education.** Chapters two through eleven offer descriptions of the ten STS programs selected as exemplary during the 1982 Search For Excellence. Chapter twelve is a synthesis and critique of the ideas found in these programs and a number of generalizations and recommendations relating to excellence in STS school science programs.

These programs are all exemplary in various ways, but they by no means exhaust the supply of innovative and outstanding science education programs. We feel strongly that excellence exists and it exists in reasonable quantity. View these as **some** examples of excellence and be prepared to find more. At the same time, we encourage you to contact any of these exemplary programs which you feel have applicability to your own school situation.

Chapter 1: SCIENCE/TECHNOLOGY/SOCIETY INTERACTIONS: TEACHING IN THE SECONDARY SCHOOL

By

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Among the various questions raised by recent reports of the "State of Education" is the question of technological literacy and the related question of the value of teaching Science/Technology/Society (STS) interactions in Science classrooms. Even the definition of "technological literacy" is unclear in the minds of many. There is a tendency among some groups to equate it with computer literacy while others agree that computer literacy is a sub-set of technological literacy.

In their study of science teaching, the STS focus group of Project Synthesis agreed that among the areas of STS study were: Engergy, Population, Human Engineering, Environmental Quality, Utilization of Natural Resources, National Defense and Space, Sociology of Science, and the Effects of Technological Development.

The last topic listed obviously includes anything a teacher would wish to include as long as it relates to the technology/society interface. This category was included because the dynamic nature of the STS area makes much curriculum obsolete as important technological developments occur in areas not originally included.

As we try to outline areas of study which are not presently being offered we are faced with the problem of student, teacher, administrator, text book publisher, and budget director acceptance. The simplest problem to overcome is student acceptance. There seems to be no order of difficulty for overcoming the reluctance of the other groups since this varies from school system to school system. It is appropriate therefore, to propose a set of desired student outcomes. These desired student outcomes will be described for each of the areas listed above with suggestions on how they might be accomplished.

Areas of Concern

Energy: Desired Student Outcomes

* Describe/demonstrate specific ways to decrease energy waste.

* Evaluate various tradeoffs associated with decisions involving energy conservation plans.

* Apply rational processes of thought to a proposed solution to problems related to energy resources and their efficient use.

* Describe and compare the relationship of energy consumption to quality of life, economics, and future development in developed and developing countries.

* Describe the role of interest groups and the tradeoffs associated with the development of an energy plan.

* Evaluate the short and long range effects of proposed solutions to the energy problem.

* Make realistic assesments of potential technical problems involved with various energy senarios.

Suggested Approach

* Have students do a survey of energy use in the home and suggest ways in which it might be reduced.

* Conduct a survey evaluating personal and family tradeoffs of energy saving decisions.

* Have students examine various personal uses of energy intensive devices and propose less intensive ways to accomplish the same task. Various devices from electric toothbrushes to autos and bicycles should be compared for energy cost and benefits.

* Through text material, periodicals, and media present STS relationships. Discuss these and have students graph energy use against GNP for various countries, as one example of a comparison. There are many others.

* With guest lectures, films, and/or simulations present the views of conflicting groups on nuclear plants, oil versus coal powered plants, gasahol compared to gasoline and diesel fuel for cars, mass transit or personal autos for commuting, and so on. Have the students discuss the strength or weakness of the arguments based on their understanding of the technologies involved.

- Make calculations of oil resources and use. Even if the top ten miles of the earth's crust was completely saturated with oil it can be shown that if oil use continues to increase, the world will run out of oil in approximately 200 years. Compare this with other suggested long-range energy sources.

- Conduct studies of chemical situations involved in acid rain, biological effects of high and low level radiation, physics of mass of auto and energy use per mile. Discuss how these various science concepts are involved in decisions regarding the technology-society interaction.

These various desired student outcomes can be considered at different levels in the secondary schools. The level at which the student is expected to perform will depend on the maturity of the student, science background, and time spent. This will, of course, depend on whether the material is taught as part of a full course in STS or is infused into the existing science course. The other areas of concern are treated in a similar manner.

Population: Desired Student Outcomes

- Discuss the implications of alternatives regarding population planning on a national scale.

- Describe the impact that technological advance has had on the family unit.

- Describe the impact that over-population and population distribution have on service elements of society (i.e. energy transportation, health care, supplies).

- Describe how over population will affect environmental quality.

- Describe the long-range consequences that population control will have on other structures of society.

Suggested Approach

- Study the Rumanian situation in which a governmental decision to halt all abortions resulted in a doubling of the number of babies born from 1966 to 1967. Implications for various facets of the society including education, baby carriages, toys, and marriage patterns 18 to 22 years hence should be discussed. Contrast with the Chinese decision on the one-child-per-family program and its consequences.

- Through films and simulations show how improved transportation has resulted in population shifts in urban-suburban regions and how improved technology affects the age distribution in a population. Discuss the implications of such changes.

* Readings, films, T.V. and discussions can show the effects of over-population on society. Experiments of growing bacteria in closed environments will demonstrate what happens when population grows too fast. Discuss the "harvesting" of wild deer to prevent over-grazing. Make calculations of per capita needs for energy etc. Enable the development of models for "Limits to Growth."

* Discussions and demonstrations on rate of filtration of sewage will show the effects of high population density on one facet of the environment.

* Discussion and computer simulations of population control strategies will demonstrate the inertia involved in population growth and control.

While the suggested approaches to help students achieve the desired outcomes are stated very briefly, it is evident these are considerably different from the traditional classroom. The preparation of teachers to carry out these approaches must also vary from community to community and from class to class. Cooperative approaches among science and social science teachers in some cases is very beneficial, sometimes requiring the surrender of tradition as to who should teach what.

Human Engineering: Desired Student Outcomes and Approaches

* Describe various methods of human engineering ranging from physical changes such as organ transplants to cloning, genetic engineering and behaviorial modification (which many of us refer to as education). Class discussions following readings, films, or speakers are useful. Having students get involved in deciding which person from among seven or eight (biographies provided) should get the next available kidney transplant makes the subject more "real" and involves exposing one's values. This in itself results in "behavior modification" of the students.

* Accept responsiblity for decision making regarding the solutions and/or directions of family situations (e.g. living will, organ banks etc.). Again, simulations and role playing activities regarding the "heroic measures" of respirators or heart and lung machines for the prolonging of life can result in encouraging students to examine their values and how their values are involved in decision making.

* Be aware of the value of genetic counseling as a mechanism for personal human engineering and demonstrate some appreciation and understanding of the impact of human engineering upon traditional belief systems. Obviously many

people discuss the pros and cons of genetic engineering without having the slightest ideas of what it is or how it is accomplished. The need for such knowledge becomes apparent as the teacher uses the students' misinformation on the topic as the basis for real study.

Environmental Quality: Desired Student Outcomes and Approaches

Students should be able to:

- Identify those elements in the environment which contribute to or distract from environmental quality. While this seems to be rather straight forward, a class can become divided very quickly on the definitions of environmental quality as it affects them personally. While loud rock music might be quality environment to some there are others to whom it will be a serious detriment. Measuring the loss of hearing at high frequencies with audiometers will bring home the danger of high volume music.

- Describe the significant role that the individual and family play in contributing directly and indirectly to the environmental quality. A study of the process by which alumina is seperated from clay, how alumina is processed to form the metal aluminum with a careful a accounting of the energy used and the waste products formed is a very important exercise. When this is compared to the energy used and the positive effect on the environment which results from the recycling of aluminum cans, foil, pie plates, etc. rather than disposing of them in the picnic areas or on the highways will bring home rather dramatically how the family can play a significant role in contributing to environmental quality.

  Plastics as phonograph records, plates, cups, etc., can be traced to petroleum and contributing to the depletion of natural resources while adding to the solid waste disposal problem. Comparing use of plastics against paper for similar uses is interesting. Paper comes from a renewable source and is biodegradeable.

- Employ skills and knowledge to improve his/her environmental quality. Activies listed above and the study of household use of pesticides and commercial garden fertilizers as compared to introduction of natural insect predators and natural fertilizers is a positive way to develop the necessary knowledge and skills and to encourage the student to employ them while developing personal values towards an improved quality of environment.

Going along with the development of skills and knowledge necessary to deal with environmental quality on a personal level it is also necessary that the student develop ability to perform tasks involving environmental quality on the community, state and national level. Students should be able to:

* Describe those characteristics of society that substantially decrease environmental quality (e.g., over-popultion, excessive use of chemicals, lack of control of the disposal of various wastes which contribute to air, water and soil pollution). A study of the production of sulfuric acid from S02 and water or nitric acid from nitrogen oxides and water will enable students to understand how acid rain is produced. Neutralization of an acid with calcium hydroxide will demonstrate why some lakes suffer from acid rain while others are seemingly immune.

  There are many activities in which students can be involved, acquiring knowledge necessary to not only describe the characteristics of society which tend to decrease environmental quality, but also discuss intelligently some proposed solutions A study in Earth Science of how water travels underground should form a basis for understanding how difficult it is to trace waste plumes from toxic waste dumps, and therefore why it is so important to have environmental impact studies for many industries and their disposal systems. A study of why shorter wave lengths of visible spectrum are able to penetrate the atmosphere and how the longer infra-red waves are reflected back to earth will bring greater understanding to the concern over C02 and the greenhouse effect.

* Be aware of the impact of this country's standard of living as the world's consumption of natural resources changes without a more efficient use of the finite quantity of non-renewable resources. Any increase in use by developing nations will reduce the amount available to the developed countries. Graphical analysis of use of natural resources and the throw-away syndrome so prevalent in a given community and country will bring about a realization of the need for recycling which alleviates two problems at the same time. It improves the environmental quality while conserving resources.

Many of the activites which should be part of the secondary school program address themselves simultaneously to energy, environmental quality and use of natural resources. One which fits this category is a detailed study of the conflicting federal government regulations regarding the automobile. A careful systematic study of such regulations and an understanding of the science and technology involved indicates that with all of its other problems, the U.S. auto industry is presented with a number of conflicting desires by government and customers.

* As we attempt to reduce pollution we add extra weight (and cost) in the form of a catalytic converter which eliminates some pollutants (hydro carbons) while increasing the amount of others (sulfur oxides).

- As we reduce size and weight to conserve energy we increase risk of danger to occupants of new small cars in collision with older large cars.
- As we increase efficiency of tractor trailer operations by using tandem trailers we decrease safety and increase road deterioration.
- As we improve highway safety with the 55 mph speed limit (a debatable point) we decrease the efficiency of delivering goods via trucks.
- As we improve performance and efficiency of automobile operation through use of microprocessors, we increase the cost of maintenance by eliminating do-it-yourself home mechanics unless they have some understanding of what a microprocessor does and how it can be overridden or replaced simply.

Actually, an entire physics course can be taught around the automobile. This course would include all of the concepts now taught in physics but would be taught as required to understand the working of the automobile as a device and as a part of the transportation system. From motion and vectors to Newtons Law, centripetal force, and relative velocity, students could study work and energy, impluse and momentum, movements of force, and rotation. It would be easy to include elasticity, harmonic motion, fluid statics, fluid dynamics, temperature and expansion, quantity of heat, heat transfer, thermal properties of matter, and the first and second law of thermo dynamics in an automotive context.

The molecelar properties of matter, mechanical and vibrating bodies, electricity and magnetism, light, radar, and the structure of solids all can be introduced as necessary for the understanding of the design, manufacture, and operation of the automobile. A study of the probability of the use of electric vehicles leads to the possible need for additional electrical generation and the study of nuclear fission and fusion.

Space Research and National Defense: Desired Student Outcomes and Approches

In the areas of Space Research and National Defense there are many problems and potential benefits to society. Study in this area should allow the individual to perform such representative tasks as to:

- Gain knowledge about research being done by military and space projects which present problems or benefits to society. For example, NASA puts out booklets and films describing many of the spin-offs of the space program. Miniaturization of electronic components was accelerated in order to send sophisticated satellites on rockets capable of small pay-loads. This miniaturization resulted in components incorporated in a heart pacemaker small enough to be implanted in the person rather than have leads from the eternal pacemaker pierce the skin with all of the resultant problems.

> It is possible for some four million students to participate in a space experiment through PROJECT SEEDS. "SPACE EXPOSED EXPERIMENT Developed for Students." The experiment, described in the March 1984 edition of **Science and Children** will enable students to find out what effect the one year exposure in space has on tomato seeds by actually experimenting with the seeds (12.5 million were sent into space in April 1984 and will be returned in a shuttle flight in 1985) and control seeds from the same source which were not sent into space. Details for this experiment are available from your regional NASA Education Coordinator.

This has been but a brief description of some of the basic objectives of a Science/Technology/Society program for Secondary Schools. There are many more objectives and activities which might apply more directly in your community schools. Implementation of such a program will depend on many factors and on the various components of the educational system. The following recommendations apply to each of those components. While it is not vital that each recommendation be carried out before some progress is made, it is obvious that unless some of the recommendations are followed very little will be accomplished in this most important area of education for the people who will spend most of their lives in the twenty first century.

A Science/Technology/Society Curriculum: Some Recommendations

* School people (teachers, principals, curriculum committees and district level administrators) should encourage textbook publishers to include STS material in their texts in all areas of science.

* School people should encourage the development and use of special publications, films, etc., presenting specific STS situations such as auto safety, fiber optics in communication, the connection between space exploration and the heart pacemaker. **Connections** and **Search for Solutions** are two such film programs.

* Using knowledge gained from recent publications of new STS developments, individual teachers should be encouragaed to develop their own curriculum materials to fit the teaching of the new development into their courses where appropriate.

* A serious attempt should be made to introduce complete courses on STS into the school program for all students at the secondary level. These courses should not be limited to either the fast learners or the slow learners of the school but rather should be directed to all citizens of a technologically oriented society as general education.

- Whether or not textbooks include STS material, teachers should be encouraged to include the teaching of STS at appropriate places in the courses they are teaching. For example, an explanation of radioactive decay could include a discussion and explanation of how the Optacon and Kurzweil machines aid the blind in reading directly from print or even from normal handwriting.

- Science departments along with school administrators, should be encouraged to discuss with any other interested groups the question of what should go out of the curriculum as more STS material comes in or, if it is possible to include STS material so that little of the standard material needs to be eliminated.

- Science departments, along with school administrators, should be encouraged to make more information regarding content of STS courses and potential careers in the STS area available to school counselors so that they might more effectively guide students into appropriate courses and careers.

- Many teachers are concerned that the inclusion of STS materials in their courses is not acceptable to state agencies and colleges. The state education department should make a special effort to assure teachers that the inclusion of such material is not only acceptable but is actually desirable at all levels.

- One of the problems which crops up regarding STS issues is that in some areas of the school, there is much "preaching" either for or against technology without the opportunity for students to make decisions which require a look at a number of alternative solutions to a specific problem. The energy crisis is one area in which social science and science teachers could work together to provide students with the opportunity to develop and examine all alternatives in the areas of education, legislation, and technology as potential solutions to the problem. They must then be encouraged to look at the secondary and even tertiary effects of each of the alternatives until they develop a real understanding of the statement: "For every complex problem there is usually an answer that is forthright, simple, direct--and wrong."

- As clearinghouses are formed to include information and even curricular materials in the STS area, school teachers made aware of them through their administrators and be given encouragement and time to explore their contents for possible inclusion in their teaching.

- State and local school systems should develop materials and systems for finding out what the students at various levels already know about technolgy as a basis for developing programs for carrying out the above recommendations.

- Existing course of study should be evaluated, and material which is obsolete or not relevant should be deleted. This will provide "space" to infuse into existing science programs selected STS topics. Infusion of such topics into courses that are required (such as middle school science, general science, etc.) would insure that the total spectrum of the student population would be exposed to this important area.

- A wide range of materials should be developed supporting both formal courses of study as well as community information programs. These would include such STS materials as: learning activity packets; movies; slide-tapes; compendia of articles from magazines (e.g., Solar Energy Digest, Popular Science, Mechanix Illustrated). Files of local field trips and community guest lectures should be established.

- Preservice and inservice teacher education programs must contain systematic strategies to develop teacher awareness of the importance of including STS in their science courses as legitimate subject matter for study.

- Since curricula for Grades 7 through 12 appear to reflect the disciplines as modeled in the universities and since teachers tend to teach as they were taught, it is important that new courses on STS and technology education be developed at the college level. Such courses would serve not only to educate students about appropriate issues and provide training in appropriate skills, but would serve as models for emulation to establish the credibility of STS in public education. These courses should be offered not only through the college or school of education, but also by the departments normally associated with arts, sciences, and engineering.

- Because few people even know that technology education materials exist and because there is relatively little general knowledge regarding technological topics and issues themselves, we suggest large-scale national campaigns to increase the awareness of technology's impact on human lives. This campaign would be directed to teachers and their supervisory counterparts, to teacher educators, and to those involved in curriculum development, especially authors and publishers of widely used textbook series.

- Biweekly newsletters entitled something like "Science, Technology and People" could be made widely available to teachers and others. They could include articles on the application of science principles (heavily valued by teachers) in technological developments and discussions of the positive and negative effects of these developments. Remembering from our data that teachers listen to other teachers more than to anyone else for curriculum advice, there could be articles written by teachers about technology-related class activities, field trips, etc., and individual or classroom activities could be included.

* Because of the dominance of textbooks in science education their selection becomes an extremely important decision at the local level. Criteria for textbook selection should be developed in such a way that they reflect science-technology-society concerns. Such criteria could be converted into check-lists for use by states and localities in textbook selections. If such checklists had the credibility of endorsement by science teachers' organizations (e.g., NSTA) and organizations of scientists (e.g., AAAS), there would be a better chance of their use in the decision process.

Chapter 2: UNIFIED SCIENCE MODULES FOR HIGH SCHOOL

By

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Recent major studies have sounded an alarm for the condition of science education in the United States. But, over a decade ago, research conducted at the University of Wisconsin established the trend toward scientific illiteracy--when it was found that scientists viewed their enterprise differently than the lay person and this discrepancy between the two groups was cited as evidence for needing change within science education. Others recently pointed out that, while students intent on science careers appeared well cared-for, most students not intending on science careers took no science after 10th grade. A primary reason given for this mismatch was that most high school science courses focused on the structure of an academic discipline.

Writers also attribute the decline of science education to the low priority of science in school systems, the dominant role of textbooks in science instruction, and the dominance of goals related to academic preparation to the exclusion of those related to personal life, scientific literacy, societal concerns, and career planning.

Science teachers at Wausau felt their project had to solve four traditional problems:

- Over emphasis of the academic disciplines
- The preparation (for science in college) ethic
- Ommission of study of the nature of the science enterprise and its relationship to self and society
- Little local relevance.

From this statement of the problems, need was recognized to change **from** a curriculum which was discipline-bound, textbook-dominated, dedicated to preparing all students as professional scientists, lacking in treatment of science as an enterprise embedded in society, and without local context, to a curriculum which was interdisciplinary, free of dominance by inappropriate textbooks, responsive to interactions of science and society, and locally relevant to students through locally produced, responsive-to-need modular curricula.

Our Response to the Problems

Our partial response to the problems in science education resulted in replacing the former Physical Science (IPS)-Biology sequence, required in ninth and tenth grades, with what became a new two-year, unified science requirement at Wausau West High School. The setting is a buiding constructed for modular scheduling. It opened in 1970 and now has an enrollment of 1,520 students in grades 9-12. The full-time-equivalent staffing of the building is about 78 teachers. The science department, located on the second floor of the building, is designed to function radially from a central storage and preparation area. A study center is provided for as are both large and small group meeting areas. A greenhouse is outside the building; a planetarium is located on the first floor.

Science for General Education

We have as a primary goal the development of scientific literacy among high school students. Our goals go beyond mere recitation towards application of facts, theories and laws of science in a context of solving problems, understanding what scientists' believe and how they act, and understanding how science operates and interacts with society.

We originally believed in the "preparation (for college) ethic," but study of the purposes of science education revealed discrepancies between our beliefs and practice. We preferred a curriculum designed around the students rather than the disciplines and for intellectual rather than strict utilitarian purposes. We agreed, although with some reluctance, to try to develop a new curriculum on the condition that a measure widely recognized as a normative test of scientifc knowledge would (with Board of Education approval) determine acceptance or rejection of the new curriculum. Our continued existence tells the story; no deterioration in our experimental group resulted, and indeed, important gains may have occurred. Our Board adopted the curriculum and the Wisconsin Department of Public Instruction formally validated the project.

The teachers who developed the curriculum feel it better serves all students. Students not naturally inclined toward science seem to find the curriculum more palatable than the discipline-bound curriculum. Our evaluative research also suggests that the curriculum enhances attitude toward school and motivation to learn. The science-talented students experience no detrimental effects as measured by meeting college entrance requirements, acceptance to summer science enrichment programs, and greater numbers of students are electing science courses beyond the required 9th-10th grade sequence. Approximately four hundred students who formerly were required to complete a biology course in the 10th grade now study unified science during that year, and of those, over 100 elect to study biology in the 11th or 12th grade.

Four Components for Science Education

The taxonomy of science education set forth in the Wisconsin Department of Public Instruction's **Guide to Science Curriculum Development** used as a basis for the project identified four major components in a K-12 curriculum:

- Science concepts
- Science processes
- The nature of the scientific enterprise
- Cultural implications of science.

It related these to six major conceptual schemes with a hierarchy of subconcepts for each to provide an adequate sample of the scientific body of knowledge for curriculum development purposes. We also used the skills associated with science processes listed and defined in hierarchical form in the guide as adapted from the AAAS curriculum, **Science, A Process Approach,** and statements of the nature of the scientific enterprise (a philosophy of science) and interactions of science and society also from the Wisconsin DPI Guide.

It was felt by teachers that a curriculum having reasonable balance among the four components would promote scientific literacy among students but our prior curriculum lacked such balance by emphasizing science concepts, occassionally treating science processes, and largely ignoring the nature of science and its social implications.

Some of the teachers of biology resisted the change because it threatened to (and ultimately did) displace their required course, relegating it to an elective on the same basis as chemistry, earth science and physics. Others favored the notion of experimental change. The key events seemed to surround the decision to change. When finally the staff made the decision to proceed with an application for ESEA funding for the project, an intellectual road-block occurred. The group knew it wanted to have balance among the four curricular components but could not identify a method to accomplish this. Finally, after grappling with the problem for some time, we arbitrarily selected a system of attack which worked quite well--the process component was to be the most basic of the four. Each module would involve science process skills, with basic skills stressed in ninth grade and more advanced skills introduced in tenth. Six kinds of modules would be developed, corresponding to the three remaining components, each taken in combination with basic and advanced process skills.

We agreed that no single module would attempt comprehensive treatment of its specified components although comprehensiveness would be sought across modules of a particular variety. Each module also would involve two or more disciplines and would give major emphasis to its designated components, but would not necessarily exclude minor emphasis for those components not designated for the module. The system worked and, over three years of development, we revised each module annually.

Teachers found the newest experiences in modules involving the nature of science and its social implications; these evolved as favorites. Students also enjoyed subjects having strong relationships to society such as nutrition, poplulation and energy. Student illiteracy about the nature of science was striking; for example, students had difficulty accepting that scientists generally assume things in nature can be comprehended. Many students, it was found, apparently assume that no one, not even scientists, try to comprehend "things that are too complicated, like the brain." Students often did not associate natural events with natural causes; supernatural causes of great variety seemed as good to many. Fiction, pseudoscience, and genuine science appeared to be a single package in the minds of many students, confirming that treatment of such components was sorely needed, especially for students who terminate their formal science education in tenth grade.

Use of a Modular Curriculum

A modular curriculum offers several advantages over the usual courses of one-or-two-semester duration. Modules may be easily replaced or revised without disturbing the entire curriculum. Modules of five to seven weeks duration provide needed refreshing changes throughout the school year. Continuity and closure are easier to accomplish for a module than for a lengthy course. Students and teachers maintain interest better when "the end" is weeks rather than months away.

Development teams used parts of NSF-sponsored curricula and teacher-contributed items from files and books. When existing materials could not be found to fill a need, teachers created them. Teachers capitalized on local resources such as, for example, geologic features. Previously required courses provided no treatment of the geologic environment while the new unified curriculum dedicated a five week module on these rich surroundings and fostered awareness and concern for the community and the environment. It was a significant change from the former curriculum which largely ignored such things.

A Chronology of the Development Project

The First Project Year (1977-78)

Our project began in June, 1977. The fifteen science teachers involved included nearly the full science faculty of Wausau West High School where the project was based, one science teacher from a district middle school, one teacher from a local parochial high school, and a secretary. We worked on a salaried basis five hours per day, five days per week, for six weeks during the summer with support from ESEA Title IV.

For two days invited external consultants gave an international perspective on unified science including its philosophical bases and curriculum development guidelines and urged the staff to venture into teaching the nature of science and its cultural implications by offering reasons for the legitimacy of such an attempt.

The local science coordinator reviewed the intent of state and district goals for science education and explained recent district progress toward those goals through recently adopted science curricula in earlier grades. The staff spent two additional days orientating its development task; mostly establishing format outlines for modular units of study. Four weeks were planned for development of six modules to be given trial use in ninth grade during the 1977-78 school year. Two weeks were scheduled for each of three interdisciplinary teams to develop one module and another two-week period was allowed for producing a second set of three modules; the final week was reserved for final preparations.

Just before writing, excitement rose within the staff. No one knew what would happen when Monday morning of the second week arrived. Some teachers thought that having two weeks for four or five teachers to put together a "little six week unit" for high school freshmen was too lavish. Others harbored uncertainty as to whether they could agree on much of anything with teachers of other disciplines. Importantly, however, the teachers were willing to try and, because of their professional pride, gave their best effort. However, it occurred that the teachers worked together very well and the available time was found barely sufficient to prepare the first modules.

Three development teams were chosen by a random draw of names from a pool of teachers with backgrounds in biology, chemistry, physics, and earth sciences. Each team took two days to outline a six week module for each of the three ninth grade design categories including a rationale, objectives related to the four curricular components, descriptions of major activities and schedules. The full staff then met to select six of the modules (reaching a surprising consensus).

The project then proceeded on a tight schedule to develop fully each module with tasks divided among team members. Teams drafted and edited modules which consultants checked for quality and validity before final editing by the production director serving as teacher-leader for the project. With administrative assistance the modules were printed on the school district's offset press (finding this to be cost effective compared to purchasing textbooks on a five-year adoption cycle).

Consultants made on-site evaluation visits during the first year of trial use of modules in classrooms, offering constructive criticism and encouragement with each visit. Three volunteer teachers and 100 randomly selected ninth grade students were involved. They found no major problems. By revising the modules based on teaching experiences, many minor problems were resolved. Mostly, an overabundance of student activities was encountered. So, need was recognized to reduce crowding within modules.

The Second Project Year (1978-79)

When the same staff returned for a six week expansion of the project in 1978, their sense of confidence was bolstered by first year research findings and teacher and consultant feedback. These factors sped revision of the ninth grade modules, and the task finished slightly ahead of schedule. Then, the staff eagerly began development of the new set of tenth grade modules.

During discussions of the design for tenth grade modules, a consultant suggested we consider science-related societal problems as unifying themes, an idea the staff had discussed earlier. A reading specialist suggested a "reading strategy worksheet" for each reading selection and reporting forms for required and optional readings. The staff also decided to print modules on both sides of the paper, reducing the bulk handled by students and teachers. All of these were incorporated as new design specifications.

Following quality checks and printing we organized an expanded ninth grade instructional team of seven teachers to teach revised modules to the full class of approximately 400 ninth grade students and three teachers to teach trial edition modules to the treatment group in tenth grade. We did not require students to remain in the treatment group beyond ninth grade. Of the 100 students who had been in the treatment group during ninth grade, 35 were lost to transfers among schools and crossovers to the traditional tenth grade biology course.

During 1978-79 the majority of the science teachers who taught the unified curriculum successfully implemented the ninth grade materials and trial modules of the tenth grade. At the school year's end evaluation was expanded to tenth grade students. Similar results from the first year showed the new curriculum to be working at least as well as, and perhaps better than, the old.

The staff reached a critical decision: "Should the tenth grade unified science curriculum replace the biology course as the final required experience in high school science?" Debate followed, stimulated by those certified biology teachers who belived biology should be preserved as a requirement. The Board of Education heard the arguments and decided in favor of the ninth-tenth grade unified science requirement.

The Third Project Year (1979-1980)

The summer of 1979 was dedicated to preparing for full implementation of the unified science curriculum in ninth and tenth grades and to revision and development of elective courses for grades 11 and 12. But, inflation reduced the time available from six weeks to five. Yet, in addition to revision of tenth grade modules, the staff decided to again revise ninth grade modules as well, realizing that revision never would end. An additional module was created to promote basic measurement and laboratory skills, and a system was created to keep refined records of student assignments. Laboratory and audiovisual equipment storage was reorganized to better accommodate the new curriculum. For the final task the staff outlined and discussed elective courses to be implemented during the next two years in response to the new student experiences in ninth and tenth grade.

Full implementation of the modular curriculum for ninth and tenth grade was completed during the 1979-80 school year with all staff directly involved as part of an inter-disciplinary team teaching either ninth or tenth grade unified science. Most staff members also taught in an area of their specialization, such as an elective course in biology, chemistry, physics or earth science. It was a very busy time. Previously teachers took an occasional "time out" day funded by the ESEA project to catch up with work or to solve problems. Most, too immersed in the intensity of implementation, didn't take the option of release time to continue development of elective courses. Consequently the funding agency granted an extension following the close of the school year.

Phase-Out of External Funding (1980-1981)

Following evaluation at the end of the 1979-80 school year, the staff again made minor revisions to the ninth and tenth grade modules. For the elective courses we concentrated on earth science, biology, chemistry, physics, and a unified science seminar intended as a return to a unified science format for high school seniors' culminating experience in high school science. Following evaluation of the project with consultants, ESEA Title IV evaluators and local school administrators, the Board of Education decided to continue the curriculum with local funds and to submit a proposal for state validation of the curriculum. Significantly, the new curriculum did not create a new financial burden for the school district; indeed, it may have saved money.

During the 1980-81 school year, the first year of full-fledged implementation of the new 9-12 curriculum at Wausau West High School, the unified science seminar was introduced, concentrating on the nature of science and its relationship to society. During its trial year students and teachers judged it quite successful. In spite of a declining total school student population, enrollments in elective courses held very well. The curriculum appeared alive, well, and dynamic with students expecting the unexpected from their science teachers. More exciting, students told of relationships between what they were doing in school science and what they were discussing at home and seeing in the news. Because the staff also observed near daily links between the curriculum and national, state and local events, this provided excellent material for class discussions.

Early in the 1980-81 school year twelfth grade students who were members of the original treatment and control groups again were tested, and again knowledge of science and attitudes toward school and learning showed no significant differences. This meant the new curriculum delivered knowledge and favorable attitudes as well as the old curriculum and, in addition, provided experiences involving the nature of science and its cultural implications.

OUR PROGRAM

The new program has brought about a sense of ownership and pride among teachers. They have confidence in their abilities to create learning experiences rather than to have them prescribed by "canned" programs. They have fun in teaching more often than before and have a greater sense of cooperation. I believe it has caused many to become formal operational about teaching science--they "think about their thinking" rather than plodding along.

Within a K-12 philosophy for science education, the staff holds four features of goal attainment to be primary for the unified science program:

* To build facility in the application of science processes to problem solving;

* To promote knowledge of the major conceptual schemes of science;

* To develop knowledge of the nature of the scientific enterprise;

* To establish awareness of the societal and individual values associated with the cultural implications of science.

With special concern for those students least likely to continue formal education after high school, it is felt goals must be achievable, at least in part, during the high school experience to develop individuals who will:

* Desire to know and understand

- Search for data and their meaning
- Respect logic and its application
- Demand verification
- Consider premises and consequences
- Perceive the cultural-social conditions within which science thrives
- Appreciate the universality of scientific activity
- Recognize the need to view scientific activity within broad perspectives of culture, society, and history
- Use achievements of science and technology for the benefit of mankind.

With few exceptions, each of the thirteen modules developed for ninth and tenth grades at Wausau West High School involve two or more science disciplines. An interdisciplinary team consisting of two to five science teachers developed and teaches each module. At the beginning of the project we decided to forego individual disciplines as a basis for curiculum development. The result involved not only the "classic three"--biology, chemistry and physics--but, in addition, earth science and environmental studies. The realtive ease with which teachers from a variety of disciplines cooperatively developed and used interdisciplinary instructional materials surprised us.

The development teams generated an informal system of checks and balances to avoid the tendency to present science as hopelessly complex theories. When developing curricular materials teachers used a typical comment, "Hold it. You are suggesting something so far in depth in your field that I don't understand it even though I have had a few college courses in your discipline. How can you expect high school students to understand it?" Teachers developed a new sensitivity of student readiness for deep disciplinary knowledge.

The teachers recognized early in the project that suitable topics were interdisciplinary in nature, something they had been unaware of from their single perspectives. Teachers also expressed pleasure and surprise at the amount of science they were learning from one another through the development and use of interdisciplinary, modular materials.

Ours was a progressive group of science teachers because prior to 1977 we had used non-textbook science materials adapted from programs such as IPS, BSCS, CHEMS, and HPP. We were quite confident from the outset that we had ability to prepare materials which would be as good as textbooks.

For each of the thirteen modules a student module was developed. These student modules were locally printed in a looseleaf, consumable form of about thirty pages in length. Separate readings for each module have replaced the textbook as a source of information. Each reading selection provides a concise statement related to a limited set of objectives. While several readings came from textbooks, others were drawn from science journals, science magazines, newspapers, and bulletins. A reading strategies page, developed for each selection, requires students to respond in writing to chosen aspects of the reading. Students are assigned two or three readings per week.

The management system for printed materials is simple. Students receive the student module for use in school and at home, meeting the time-honored need held by many, especially parents, for students to have a book. There is a significant difference between local teachers, rather than remote authors, writing the books. Now, students reading the book ask, "What do **you** mean by this?" rather than "What do **they** mean by this?"

Many staff members can recount occasions on which they could not explain what "they," the inaccessible authors/editors, had in mind in an unclear passage of a textbook. While many instances of obscurity also occurred in early versions of our teacher-produced student modules, our advantage was that the author(s) were either in the room or down the hallway and available for immediate clarification. Our unified science project demonstrates that the science curriculum need not be dominated by the textbook. We feel anchoring a science course in a textbook may be popular, but it acts to restrain science education.

Value, ethical and moral considerations are an integral part of the curriculum. Science teachers are careful not to be judgemental about issues surrounding (for example) toxic waste, pollution, energy demands, but deal with such on regular basis. We as teachers believe it entirely legitimate as persons highly trained in science to explore affective aspects of science with our students. We do so in recognition that for many students it is a final opportunity to explore science-related problems with persons expert in science.

Cooperative work is the norm on teaching issues and problems related to science. We attempt to establish through surveys, pooled data and discussions a group sense among students of conditions and attitudes surrounding problems and issues. We feel it important for students to see how their peers, as a micro-example of future society, perceive contemporary science-related issues and problems.

The curriculum subscribes to the Piagetian theory of intellectual development. Teachers studied Piaget via the Karplus series of films and printed materials gathered by the Science Consultant at Michigan State University when participating in a SCIS leadership session conducted by Dr. Glenn Berkheimer. This activity occurred at the beginning of the project, before actual development began. Teachers attempted to be mindful of need to preceed abstract ideas with concrete experiences. Dr. John Rusch later conducted a Piaget Workshop for teachers during the second summer of development work.

We do not claim to have succeeded in establishing a curriculum in direct correspondence to Piagetian theory, but we have tried. Some of our teachers have explored written student measures of intellectual development and have discussed need for collaboration with educational researchers to further explore such measures.

The program requires that the techer perceive the mission of science teaching as general education directed toward increased scientific literacy for everyone as compared to special treatment for an elite few students. We believe teachers must perceive themselves as teachers, not discipline-based scientists. Dr. George O'Hearn, project consultant, provided an acid test of perception of teacher role early in the project. He said, "If you think you are a scientist first and a teacher next, tell me about your current line of research." Silence followed among the fifteen teachers present. Since then, as a standing joke, we refer to one another as "science teachers." We love our disciplines, but try to keep them in perspective. Also, we greatly value the future scientists among our students and we believe we continue to meet their needs.

We view content more as a vehicle than an end. Some sex education (biological facts on human reproduction) was accepted as an imperative for the curriculum, but most content as shown by the titles and ingredients of the modules was chosen for its potential to serve philosophy and goals. Interestingly, one teacher observed that the choice of themes for modules which boiled out of the selection process encompassed the four elements of the ancient Greeks, and that resulted in our logo. We therefore claim, tongue-in-cheek, that the content of our curriculum includes the entire universe.

Students are presented to us at the rate of 120 per teacher. It would be nice to say that we provide individualized instruction, but we do not. It is mass education and, of necessity, we employ group-paced instruction. Within those parameters, we try to recongize individual student roles by providing alternatives among reading assignments, advanced level contract options and occasional individually designed laboratory work. We would like to improve in this area, but we are constrained by external factors.

Class sizes average about 23 students in size. However, large group instruction is directed toward 200 or more students at a time. Small group meetings occur with 20 or fewer students present. Handicapped students are mainstreamed in the building. Student attitudes are similar to or slightly more positive than in the nation as a whole. They reflect the heterogeneous socio-economic array of family background in the total community.

The percentage enrollments by average grade level size are:

Unified Science (ninth grade)	90%
Unified Science (tenth grade)	90%
Low ability, LD (ninth and tenth grades)	10%

Biology	32%
Chemistry	30%
Earth Science	11%
Physics	11%
Science Seminar	3%

44% of 11th, 12th grade students currently enrolled in electives (does not break out those enrolled in two concurrently)

With minor variations from ninth to tenth grade, our students meet on a five day cycle provided by a schedule which allows us to meet with groups of varying size for multiples of 20 minutes. In five days a visitor would see students:

* Attending a 40 minute large group (200 students) presentation orchestrated by the staff. This session may involve a lecture, audio-visual materials or role-playing by science teachers. Effort has been made to make the presentations highly motivational. On some occaasions students have been observed to cheer and applaud their teachers and talk is overheard in the hallway such as, "What are the science teachers doing today?" - this is not the norm, but we have a group sense of having shared some great moments in teaching.

* Attending a 40 minute medium group (25-30 students) meeting treated much like a traditional lecture-recitation session.

* Attending an 80 minute lab session (25-30 students) which is the focus of the weekly cycle.

- * Attending a 40 minute small group (10-15 students) meeting with the teacher responsible for student records and grading. This may involve post-lab discussion, discussion of readings, quizzes, discussion of issues, and always involves management of written assignments which are kept by small group teachers in individual student files which are shared each week with each student.

- * Reporting to the science resource center on unscheduled time to complete written reports on assigned reading selections taken from a variety of sources such as texbooks, magazines, newspapers.

- * Reporting to an open laboratory on unscheduled time to get help from a teacher or to continue work on an activity initiated in the scheduled lab session.

- * Reporting to a teachers office on unscheduled time to get help or to arrange make-up due to absence.

Team teaching pervades nearly all courses. Therefore, cooperation is the word that best typifies the teachers' roles in planning, evaluation of students and program, preparation of materials and selection of instructional strategies. Team meetings of one hour per week are used to set a plan and, in the case of the unified sequence in which all teachers participate, one teacher (usually one of the authors of the module at hand) takes responsibility for arrangements such as gathering unique supplies or arranging for field trips or guest lectures.

The program requires a gamut of teaching strategies and skills ranging from trying to hold the attention of an audience of 200 students to working one-on-one. Perhaps unique and highly valued by teachers is small group instruction which at its best requires displacement of the teacher from the center of activity. We as teachers are still learning to sit at a table with students, talk less and listen more. We strive for student-student interaction, especially when dealing with social issues related to science.

The program does not involve extraordinary expenses. We have been nipped by inflation and are limping along with equipment wearing out which we cannot replace. The current annual budget for science equipment and supplies is about $13 per student.

The staff has high involvement in professional organizations. Most teachers are involved in NSTA (four of eleven attended the annual meeting in 1982, and ten in 1983) and the state affiliate, WSST. We are very active in the latter--have held offices, hosted the annual convention and appeared on the programs informing others about our curriculum. NSTA and WSST have had more influence on the staff than other organizations such as NABT, ACS, and AAPT, although some teachers hold memberships in the latter.

Professional journals are regularly circulated, discussed, and used by teachers. For example, the current issue of **The Science Teacher** was used in two ways: (1) F. Watson's comment, "The Road to Take" was shared with the local board of education in a report by the local science consultant on recent trends in sciece education, and (2) the chart of typical power ratings in the SI tear-out was used as an overhead projection in a large group presentation in the "Fire" module for tenth grade students.

Regarding student evaluation, a negative development occurred which deserves recognition. Grading practices were changed for the unified sequence during the second year of development. We began grading students by module rather than be semester as formerly practiced. An unusually high failure rate resulted and we created administrative and guidance problems. Our new practices forced changes in grade reporting, administrative monitoring of credits earned, and scheduling for makeup of failures. This created a negative attitude toward the program by others in the school community which was called to the attention of teachers. On advice of the Director of Research, who convinced the science teachers of the lack of wisdom of their grading practices, return was made to semester grading. Had this not been done, the program may have self-destructed for other than science education reasons.

Tests continue to evolve for each of the thirteen modules produced in the project. The original design was to produce tests whose items would be in direct correspondence to objectives stated for the modules. Limited success has been reached in producing quality test items in the quick-scoring format needed for mass education. This is especially true when dealing with other than cognitive (factual) aspects of science. Item analysis of tests produced for modules revealed that only about 10% of items had acceptable discrimination and difficulty. This experience, which involved test development under better conditions than ever before, caused teachers to wonder about the trust they had placed in tests for the former program which often were dashed out in a few minutes.

Having awareness of the limited precision of our tests, we do not take them too seriously for purposes of student evaluation. Other factors including the quality of written reports on reading assignments and laboratory work, contributions to class discussions and attendance are incorporated with tests in evaluation. This has shaken the foundation of arbitrary "point systems" used by teachers for grading. Student evaluation typically requires (for success) that the student adopt the posture of behaving as a scientist.

Peer and self evaluation of teachers are implicit in the program. Seldom is it possible to teach behind closed doors in this program. We often teach in front of one another, a condition which provides self-scrutiny far more meaningful than the normally token evaluation provided by school administrators.

Implications for Other Schools

Following validation by an external team of experts in December, 1980, the staff decided, as a matter of professional responsibility, to submit an application for funds for statewide dissemination. During the summer of 1981 with support from ESEA Title IV-C we revised and refined our curriculum to serve as a Demonstartion/Dissemination Project and made minor changes to enhance adaption or adoption by other schools.

As a result of dissemination activities in 1981 and 1982 supported by ESEA Title IV, the program is being used in seven other Wisconsin schools incuding three middle schools and four high schools in grade level applications ranging from 7 to 10.

We have considerable recent experience with showing other teachers how to use our program, the bottom line characteristic is that person-to-person communication is necesary. The program embraces a philosophy of science teaching which is revealed only in part by the printed materials which can be made available to others, and on which others seem to have focus in a concrete operational sense. Our experience is that about 25 hours are required to orient other teachers to the curriculum to a degree that both they and we sense comfortable levels of understanding. Beyond orientation, other teachers need several weeks to prepare to teach the program, with local adaptations, in their schools. Our staff provides teachers from adapter schools indoctrination (as with NSF) followed by time (a difference from NSF) for local planning with occasional consultation and follow-up assistance.

Early indications from adapter schools indicate high success.

Implications for Teacher Education

Most of what we had to learn about history, philosophy and social implications of science needed for success of our program was self-taught; it did not result from our background courses in teacher education. We learned these things together and have learned to approach them with students the hard way--in front of the class. Teacher education programs are not known to us which seem appropriate for a teacher joining our staff.

We would like a new teacher in our program to be competent in some discipline of science (it matters little which) so that she/he could identify with practicing scientists. More important, however, we would like a new teacher to be well-based in educational psychology, aware of science as a mode of inquiry, sensitive to the social implications of science and adaptable to joining with other teachers in exploring how better to teach.

As disseminator of our program, we conduct teacher workshops and, selectively, have had a few conducted for us on our terms. Frankly, we believe many "experts" in science education do not have much to offer and seem to follow, not lead. We determined need in 1977 for many of the changes in science education which the "experts" now seem to be recognizing. Except for a few collegial campus and agency-based science educators who don't mind getting the soles of their shoes dirty by treading in a real school and talking on even terms with real teachers about science education, teacher education workshops haven't contributed much to our program; and they won't until a full parity relationship is established among particpants at all levels. Those who desire to design and conduct teacher workshops for the future would do well to follow the examples of Drs. Ken Dowling, George O'Hearn, and John Rusch of Wisconsin who are regarded by our staff as colleagues and personal friends of equal stature and who operate "with", not "on" teachers.

An Implication for Scientists

Notably absent from our program is any direct contribution from a practicing "pure" scientist, the lot of which seem even more remote from teaching than science educators. We sense high potential for improvement of our program by interaction with scientists, but the burden seems to be on us to initiate such interaction. This implies to us that the science community is itself illiterate about its own enterprise and is lacking in felt need to communicate via science teachers to citizens who will determine its future course.

It seems that programs such as ours will only be fostered and improved by close cooperation among teachers, university science educators and practicing scientists acting in concert with support from society.

We believe our program has high potential to be used by others in the nation for improvement of science education. For appropriate consideration, we are quite willing to share our success with others.

Chapter 3: SOLAR PROJECT CLASS

By

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Toledo High School serves 461 students with 34 staff spanning Grades 7-12. Because our junior high school burned down three years ago, an extra load is placed on the high school building which was built in 1953. Our mood now is one of staff and students pulling together while sharing innovations.

One innovation, our exemplary Solar Science Program, was established as an alternative rather than a replacement for our traditional laboratory science program. We developed this because of rather intense public awareness of energy shortages.

In the Pacific Northwest, we have an enormous effort to provide power to homes, offices, and industries through the construction of a series of nuclear power plants. In recent years this became an extremely costly and controversial issue and served to dramatically increase interest in alternative sources of energy. This is particularly true as events filtered down to residents of Lincoln County through the national television networks and the state of local press regarding the soaring costs of energy and about the "cutting edge" of a new technology.

I realized the need for the Solar Science Program when, in developing a home construction curriculum supported by a grant from the Oregon Department of Energy, students felt a need and desire for solar information but could not afford to spend a half-day in vocational programs.

Realizing an educator can provide a community with accurate information about a developing new technology through the students, a former construction teacher, Jack Peters, and I met one evening a week for two years to develop the solar construction curriculum. While John Rogers, Deputy Superintendent, and Dr. William, Force, Superintendent, gave us much needed administrative support, Mike Kenney, Curriculum and Instruction

Director, obtained State and National recognition and extended the program to other communities.

We began the change with an independent study program for two of my science oriented students and the next year we offered a full Solar Science Program. Four years proves this a very successful program.

During this time I attended a Summer Institute at Portland State University on energy education which served as a catalyst for my planning.

For several years I developed and used educational materials and units that focused on alternative sources of energy. Later, the instructor of our construction cluster and I wrote a solar energy grant application through the Department of Energy which was approved. Then my solar projects class began in earnest bringing together students interested in engineering and the application of a new technology to a practical situation.

Our enthusiastic Curriculum and Instruction Director and two specialists supplied me with current up-to-date information on energy education and conferences, initiated an ERIC search for me, and provided video and printing for publishing my program. Also helpful in developing and implementing this program were the:

U.S. National Bank;
Crosno & Jones Realty;
Glea Humphreys, a Building Inspector;
Oregon State Department of Education;
Lincoln County School District Board of Directors;
The Department of Curriculum and Instruction, Lincoln County School District; and
Kathleen Shelley, the Principal of Toledo High School.

Because the program has increased the level of communication among different subject areas, we have sought other areas of possible collaboration and cooperation as well.

Our investigation uses our TRS-80 computer with printout and a library of computer solar programs, an extensive library of solar books, manuals, brochures, solar periodicals, and solar catalogs plus two file cabinets of solar literature filed by topic.

The school district sells a curriculum manual, video tape, and slides of our program at production cost to teachers statewide who have adopted all or parts of my program. I have given workshops for teachers throughout the state and have presented parts of my program at our statewide Annual Science Inservice.

OUR PROGRAM

Our land, it's resources and uses, are the future. If we fail to design, plan, and manage our land and its resources with care, our world as we know it will cease to exist. I see my duty as an educator to become aware and to make children aware of their responsibility in preserving our environment and energy resources and to enable our students to make informed decisions, to me this suggests how vital it is to include energy and environmental education in our Lincoln County School district curriculum.

My goal is providing a community-based instructional program to develop student awareness of our environmental and energy resources. Our cross-section of students includes some college bound and some former dropouts who are working their way back into school grades 9 through 12.

Our curriculum directly considers alternative ways to meet human energy needs and specific science-related social problems--energy, environment, and human needs and demands. Because our students solve real problems in real situations and see the results of their solutions, students can see the impact in their community and social impacts of their decisions through exploring values related to energy and environmental issues.

Students' projects carry them beyond my traditional fixed lab station science classroom to the shop, home economics department, office occupation room, computer room, library, student construction house, community services, and businesses. Linking the class to a vocational construction course plus home economics, interior design, and decorating for energy efficiency allows students to explore and practice skills in solar technology which could lead to careers and awareness.

Essential content for this awareness is:

- Development of positive attitudes toward the use of energy/ environment,
- The implications and consequences of energy uses and policies local, national, worldwide,
- The understanding of solar and other alternate energy systems and their component parts, and
- The development of students' self-concept and worth.

Students play a very active role with little visible, formal structure from an instructor. And the community and its resources are seen as integral parts of the program. We relate the use of the natural environment and solar energy as a renewable resource available to the community through students' ideas and needs.

Personalized instruction gears the program to individual interests and instructional needs of college bound as well as potential dropout students.

The affective and experiential emphasis focuses instruction on projects and application of the information covered and decisions on problems and issues and students therefore learn to make decisions based on the knowledge gained through lectures, research projects and experimentation.

Teachers use a variety of techniques. A typical five day period brings lectures, slides, or over- head diagrams of some aspect of solar energy, emphasizing science principles. I use these more directive strategies the first day. But, during instruction, I generally try to remain extremely flexible, letting students develop purpose statements and then introducing appropriate activities.

On the second day students usually discuss solar current events, formulate evaluations of yesterday's lecture and discuss evaluation in general. Next, we try to take a field trip to a local passive solar home or commercial solar installation. The fourth day brings research on situational problem solving state- ments and individual student-teacher interaction. On the last day students work on physical solar projects, solar building designs, or architectural scale models while the teachers avoid getting in students' way and stifling creativity. Teachers never say it can't be done and avoid pushing their personal values on students. We let them explore and develop their own ideas and values.

Before students solve their own projects and problems I use the materials for building background experiences such as **The Passive solar Energy** book, Redale Press, 1979, by Ed Mazria, "Introduction to Energy,"

"Understanding Solar Energy Systems" - New Mexico State University, revised and edited by Wisconcin Vocational Studies Center, 1978.

Providing for Energy Efficiency in Homes and Small Buildings, Part I, II, III, Teachers Guide and Workbook, June 1980, prepared by the Department of Energy, Office of Consumer Affairs, Education Division, Washington D.C. 20585, DOE/IR/06065-1

We also use our TRS-80 computer with solar programs, some of which I developed. I use video playback for video films on solar education and "Solar Refitting" by Rodale Press--my own solar program developed with grant funding. A short informal lesson plan covering the implication of energy uses and policies local, national, and worldwide might look like this: Students begin taking notes and discussions with the teachers assisting by projecting students experiences to national and worldwide consequences. Teacher notes serve as a guide to get the ball rolling covering all the essentials points. During the first four weeks of the school year I disseminate the above background information.

Our Field Trip Lists suggest the nature o our course and includes:

* Commercial pasive and active buildings,

* World's largest vertical axis wind generator,

* Passive and active homes,

* An Earth sheltered home,

* A Micro-hydro electric project,

* A Hybrid solar home, and

* Various types of domestic hot water installations.

EVALUATION AND SUPPORT

We evaluate students with written tests, oral questions and interaction, project worth, student involvement and communication with the student and others.

I have never known a student that did not offer something positive to others and the class. Every student is worthy and unique. The same is true of teachers. The key to evaluation of teachers is their enthusiasm and participation.

Four of my students entered a five county laboratory skills fair sponsored by a college. My students brought home a First Place Team trophy and two First Place Individual medals.

Support is given to the program in a number of ways. The school district has provided matching funds for the Solar Projects Class and they have made their materials center as well as their production center available to the class. The District has entered my name into it's Talent Bank in order to give me the opportunity to inform other teachers and community members about the class. And this school district has been the site for a statewide vocational educators meeting in which the Solar Projects Class was featured.

Students, parents, and community offer considerable commitment and support. If you really want to know about the impact of your program, go to the barber shop, hardware store, and local pizza parlor. Listen to people talk. Even at home, energy is a familiar topic. My class activities have a natural flow into the dinner table conversation and the home discussion is rebounded back to my classroom the next day.

Within my school, administrators have also been extremely helpful. They demonstrate initiative in informing students and parents about the class. They also provide material support and a consistently warm human support for this effort.

Perhaps the most important way has been the manner in which the principal's support has been generated. In short, her position is that we have something very special going on educationally that is "good for kids" and "needs everybody's support."

Professional organizations provide me with information and ideas while letting me know about national programs and trends. From the journals I have been stimulated and learned of workshops and institutes and products useful to me. Our school circulates several professional journals but I find **The Science Teacher** most useful.

By continuing to work in the community and attendance of State and National conferences I can stay at the cutting edge of technological developments and concerns (with my administrators' help).

I communicate with the community through service on the Advisory Committee for the Oregon State University Extension Agent on Energy for our county and two adjacent counties and through my own private firm--Energy Cross-roads Consulting.

SOME NEEDS

My program needs a larger and more open classroom and extension beyond the community to go statewide field trips and state and national solar conferences. And, I always need more planning time.

To insure success, it is vital to maintain field trips, student involvment in planning, and teacher enthusiasm.

The pressures on human kind to find less expensive means of providing a comfortable and healthy living will force secondary schools to develop programs which teach the practical application of new technologies while meeting these major challenges and giving students a sense of responsibility towards solving major problems.

Many may use the program if there was national dissemination, something which is underway. If teachers wish to use my program they must adapt the program to their personal needs, needs of their students, and community concern. To establish a program teachers should view our video program, look at our curriculum manual, and develop a program to fit their community resources. Then, accept students where they are, work with them from their own background and experiences to build their self-concept and you will be rewarded with student achievement, improved self-concept, and teacher recognition such as radio and press coverage.

As more schools instigate energy education programs we will try to extend video, slides, and curriculum guides at cost. I am confident that our program works, works well, and does make a difference in student, teacher, and community understanding and attitude. We need these positive attributes if we are to have an energy secure future.

Chapter 4: ENVIRONMENTAL SCIENCE

By

Virginia Carol Demchik

and

Michael J. Demchik

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Scott High School, in Madison, WV, a city of 10,000 and the county seat of Boone County, is located in the top coal producing county in the state. Twenty six teachers, a guidance counselor, an assistant principal, and a principal, serve 561 students in grades 10, 11 and 12. About 40% of these students continue their education, a proportion which has increased over the last seven or eight years from about 25 percent. Our three year old building was part of an extensive county building program, but because of escalating costs, various science programs and equipment purchases have been slighted, resulting in limited science facilities, materials, and equipment. An Environmental Science Club at Scott in April 1982, started the environmental study area for the school, the Developing Arboretum and Nature Trail located about two blocks away on a hillside. Teachers continued the program during the 1982 summer at no cost to the board of Education by using donated materials and services.

The program, currently used at Scott High School only, may expand to two other high schools in the county. It started in 1980 as a 7 to 8 week pilot program, the first environmental science program in the county.

A 1979 review of the high school and junior high school yearly CTBS test results revealed deficiencies in students' knowledge of the environment. Alarmed because this is a top coal-producing region, we wrote four general goals and 16 objectives for a high school pilot program on "Energy and Energy Related" activities and located materials and equipment for the program without county or school funds. We wrote new materials and modified existing materials to fit the program, primarily on our own time.

The students received it well and showed significant improvement in their knowledge of the envrionment so we expanded the pilot program. The school administration supported us by allowing us freedom in developing the program.

However, like any physics course, ours already covered a great deal of material, and while this pilot project was successful, a question still remained whether it should be made part of the physics program.

During the pilot project, analysis of the results from the October 1979-80 CTBS Comprehensive Test of Basic Skills, revealed a need for activities to teach the action and interaction of environmental effects. Potential core areas for study were examined and four purposes for the program of study were developed.

The course title "Environmental Science" was established, the overall objectives were developed, and the locating of materials essential to the program began. In March 1979, an exemplary program was located through the National Diffusion Network which provided four basic two week programs intended to be incorporated into regular Secondary Science Programs. In June 1979, a proposal was submitted to the Title IV-C Office of the West Virginia Department of Education for funds to implement that program. The pollution control program was funded for the 1980-81 school year. Each area adopted from the exemplary program required considerable expansion. A variety of resources similar to those developed for the Energy program in physics the previous year were examined. Many of those materials were utilized for the Environmental program and each adopted package--"Open Lands and Wildlife," "Water Pollution," and "Air Pollution"--was similarly expanded. Other materials were also secured, developed, and analyzed to meet the established objectives.

Specific Population for whom course was developed

The course was developed as an elective science course for 11th and 12th grade students. However, the course is open to students in grade 10 as well for the 1982-83 year. There are no entrance requirements for this course; it should provide all students with the opportunity to become more informed citizens. However, the course is not an easy one, and students enroll who also participate in upper division science courses. Guidance toward this program is accomplished in the Science classrooms of the school.

CLASSROOM

Michael has developed a supporting nature trails program available to all 23 schools in five county locations since the start of the Environmental Science Club. Michael, now a county teacher, developed these trails in support of our county's trails program.

Our classroom, 850 square feet, has 30 chair-desks, lab facilities along the back and one side of the room, demonstration desk and storage area at the front, and a moveable cart-table. Laboratory activities often take place at outdoor lab sites, the Developing Arboretum, Nature Trail, and nearby river.

The basic aim of the Science Department at Scott High School is to develop in students an understanding of the laws of nature and to make practical application of these laws in an ever-changing society. Our objectives include:

- To gain the command and the use of basic skills of reading scientific literature for information, ideas, opinions, and leisure
- To display growth in the use of scientific facts and principles and to make practical application of them
- To prepare students interested in scientific, technical careers, and science related fields for study beyond the high school level
- To understand the techniques and use of the scientific method in solving problems
- To make students aware of the possible applications of scientific knowledge in the solution of important social problems
- To gain an understanding of human physiology and its relationship to health, nutrition, and reproduction, and to establish practices and procedures basic to maintenance of good health and physical well-being
- To develop an inquiring mind, one that is intellectually curious and industrious, capable of critical thinking, and seeking valid evidence and making reasonable conclusions
- To have an understanding and an appreciation of the integral forces of our environment
- To understand and develop possible applications of the new and different forms of energy in their future.

CURRICULUM

As goals for our students we try to provide opportunities to examine, analyze, evaluate and react to problems in today's world and the future world based on known environmental conditions in our community, state, nation and world. We concentrate on water, air, light and noise pollution; coal, petro, nuclear and associated future energies: fuels and potential fuel sources; and wildlife and wildlife resources.

We develop alternative solutions to problems, examine attitudes and life styles affected by the environment and examine career opportunities in Environmental Science. We present societal issues through facts and simulated situations, laboratory activities and visits to reclamation sites as well as through visits by career people in environmental science areas and consumer products produced from space age technology.

Some students attend the Regional Intergovernmental Council meetings and analyze historic river and land citations kept in the county courthouse. Students participate in four simulations; water pollution, nuclear energy, nuclear war, and air pollution and study clean air and water amendments in each major area.

All activities have two components, structured and open inquiry while the four simulated situations and follow up discussions to independent study raise social issues. The simulated situations also develop student cooperation skills. Students work in groups of three on almost all activities.

One major goal, career awareness, as an integral part of all science courses at Scott High School, correlates class activities with visits from professionals such as nuclear specialist, forester, energy auditor, agricultural stabilization person, soil conservation specialist, 4H leaders, meteorologists, extension service agents and West Virginia Department of Natural Resources personnel.

The course considers community, county, state, national and world environmental problems but starts with a focus on local concerns. We present environmental issues and projects to local garden clubs, 4H folks and PTA's. One year a group of concerned students independently approached the city council. Concerned about grease spills by a local restaurant, the students presented their concerns and the situation was corrected.

The program contains elements of independent study, laboratory activity, role playing, field trips, library research, lectures, films, and visitations of resource people. At first, students learn about the local community, and then the course expands to include the State, the Nation and the World.

The academic content includes the following general areas of study:

* Open Lands and Wildlife

Biomes, ecosystems, niches are defined and the emphasis is placed throughout on balance in nature and those factors which affect stability and survival of systems. Included as well are practical courses of action or alternatives that can be utilized to establish balance. Land use studies are investigated. Included are reclamation and transport of animals to provide balance. Emphasis is placed on population studies.

* Water Pollution

Water cycles and water testing, waste treatment both domestic and industrial are studied. Oceans, rivers, lakes and ponds are studied in conjunction with maintenance of balance and interactive effects required to maintain that balance and the effects of pesticides on that balance. Legislation is examined.

* Air Pollution

Inorganic and organic compounds that are primarily responsible for major pollution effects are studied. Particulate pollutants such as soot and metallic residues are included. Effects of life both plant and animal are studied as well as the upper atmosphere. Legislation is examined such as the clean air amendments. Effects on living things are studied.

- Energy and Related Activities

  Energy relationships including major physical interactions, relationships to living things such as energy transfer situations are included. The study of wood, petroleum, solar, thermal, mechanical and nuclear energies are included. Pro and con relationships are investigated. Energy saving measures are included and a school energy audit is performed. Legislation is examined. School energy saving measures are incorporated. A student energy conscious team is generated from the class. Student simulations of congressional hearings takes place.

- Resources and Related Subjects

  Energy and energy efficient automobiles, engines, pollution legislation and energy saving tips are included. Metal salvage and recycling are investigated. Population statistics are treated. Energy saving mechanisms and materials are examined that have been generated for use in the United States Space program with respect to industrial applicability. A food health section is utilized in conjunction with energy and energy transfer materials. A problem solving competition dealing with a variety of topics under the title: Energy Problem-The Ecological Crisis is utilized. Topical ideas such as population statistics, recycling, pesticides and other topics are presented.

These five major areas are investigated through testing in the field as well as classroom laboratory. Local government personnel are used to determine a wide variety of studies including land use, citations, and river clean-up and fish stocking. Resource personnel are used in the classroom including a nuclear specialist, forestry, conservation, and agricultural stabilization personnel. Lecture and discussions are used but a good percentage of time is devoted to independent study aspects through library research, Science Screen reports (recently updated information on the frontiers of science), field trips, (Hobet Mining Company and reclamation sites). The West Virginia Fuel and Energy offices are used heavily for topically new information. The county home economist who also serves as a resource person in energy related activities is used for updated materials.

EVALUATION

We test two elements, the factual and the situational. The entirely situational final exam last year assessed environmental concern and students had to analyze, evaluate, and produce alternative solutions. Our two point evaluation process evaluates students subject coverage, animal identification ability, and source variety. Our evaluation also includes a daily grade of class participation and at the end of the lesson essay and objective tests. Our course covers topics of water, air, light and noise pollution, coal, petroleum, nuclear and solar energy sources, test on soil, air, water, and energy audits. Our specially designed pre-post semantic differntial assesses values and attitudes on moral and ethical issues.

I also evaluate students by written tests, lab reports, in-class lab grades, and grades on simulations and independent study activities.

We evaluate the program through student pre and post course attitude on societal issues, follow-up on student graduate's attitudes toward the program, and pre and post testing with the CTBS subsection for Science.

In 1980-81 student attitudes were examined and showed significant change in most areas. Therefore, the objectives of the course remained essentially the objectives of the 1980-81 course. However, on the basis of teacher and supervisor interaction several new objectives were identified and included in the 1981-82 course to make it comprehensive. In 1981-82 the course was evaluated by pre-and posttest comparisons of the Science subsection of the CTBS, Comprehensive Test of Basic Skills, with matched pairs of students, one of whom had taken the course and one of whom had not.

Our students average at the 73rd percentile on of the CTBS Science subsection and many have won awards at local, regional, and state science fairs; one made a trip to the International Science Fair. Several attended a special gifted summer science research program and received awards for their work.

The current school year assessment was completed after the final test in May 1982. We also include test data and attitudinal data for the "Energy and Energy Related Activities" pilot program in 1979-80 and for the first full year, 1980-81, of the environmental science course operation. A follow-up study on students in the first year course was instituted in an April 13, 1982 mailing.

The analysis cited show statistical growth in all areas studied. While a control group was not utilized in the initial study, matched pairs of students having similar achievement characteristics were examined in May, 1982, showing unparalleled achievement for students in the Environmental Science course.

The Science supervisor and instructor evaluate test results each year. We examine attitudinal data and determine whether to emphasize or de-emphasize certain program components or to incorporate other objectives, such as the new objectives that were added to the 1981-82 course.

The classroom teacher collects the data. The science supervisor is primarily responsible for data analyses, although the classroom teacher helps interpret them. "Cold hard facts" do not always tell the whole story.

INSTRUCTION

The timely information from students' work in the local environment provids an impetus for them to understand the forces acting in their own setting, particulary things they are most familiar with. Students do library research, work in large and small groups, view films and filmstrips, work in outdoor and indoor laboratories, listen to tapes, write computer programs, do role playing and simulations, work in groups and individually discuss materials, write reports, and perform nature trail activities.

We use water, air and soil studies kits worth $722 and computers provided by the Board of Education for data analysis and use. We bring all materials to the classroom prior to each class and return them afterwards to the science department central storage area.

Students vary in ability, but we accomodate as many interested students as possible so class size has grown from 12 to 28 since the pilot program. We offer the course only once a year. One unit of Science is required for graduation so 100% of the students take biology, 20% take chemistry, physiology draws 12% of the students, 10% take our environmental science and astronomy and physics both draw 6%.

We prepare all materials, including daily lesson plans, lab materials, and the teacher devised evaluations except the mid-term and final exams. We direct activities, demonstrate and lead discussion, but seldom lecture, and we present facts and processes for student decision making. We introduce all topics with an initiating activity or string of activities. We always initiate discussion leading to a film or filmstrip study, library research, independent study, further activity or tape. Further discussion format produces more questions.

The methodology and the developmental cognitive approach are the most important aspects of teacher education for success of the program.

At times we extensively test both soil or water quality. Four times a year we simulate public and senate hearings in conjunction with four or five major topics.

The students enjoy the study of West Virginia Wildlife lessons which usually lasts about 4 weeks, beginning with a walk on the nature trail near the school. First they observe animal tracks and evidence that something has been in the area. Then they study what animals can be seen, what habitat is most needed by each animal, what predator must be avoided by this animal. Next using OBIS, CESI and other sources, they examine the world of animals from the animals' point of view, color discrimination, prey-predator relationship, visual limitation, visual/light relationship, food limitation, food shortages, consumer-producer web, food chain, holding capacity.

Through the use of films, filmstrips, and library research, students study an animal of choice and write research papers, later shared as oral reports. Many share their experience in the woods, in hunting, or with pets. A lecture/textbook format would cause the failure of the program.

MATERIALS

We wrote many of the course materials. Supplemented materials were added using junior college texts and drawing from six national environmental programs; Outdoor Biological Instructional Strategies, Project Learning Tree, Forest Service, You and Your Environment, Acclimatization and Council of Elementary Science International.

Free materials are available from Exxon Corporation, American Aluminum Companies, American Steel Makers, Amoco Corporation, West Virginia Extension Agency, West Viriginia Fuel and Energy Office, Canadian Wildlife Association, Appalachian Hardwoods Association, American Oil (Petroleum) Institute, National Science Teachers Association, Science Screen Reports, West Virginia Department of Natural Resources, National Weather Service, Modern Talking Picture Service, West Virginia State Police, Atomic Energy Commission, Appalachian Power Company, Hope Natural Gas, Priority One--Union Public Schools (Union, N.J.), U.S. Department of Agriculture, Phoenix Quarterly, Environment and Survival (filmstrip/record), and the U. S. Department of Energy.

Since there was no textbook available for the course, most material in this program is drawn from free and inexpensive materials. Suggested resource lists can be made availble. Primarily laboratory materials are found in a regular lab setting. However, one essential ingredient required in the water pollution unit is the water testing kit. The soil and air kits can be generated from regular lab materials. The cost is shown below and included is the soil and air kit cost:

1 soil testing station	$145.00
1 air pollution kit	204.00
1 Reagent system-Economy pollution kit	372.00
Total	$721.00

PLANNING

The principal encourages all teachers to improve their competence and incorporate new techniques. The teachers write goals and objectives for the courses they teach, and revise these each year.

To make program decisions on statistical results, we rely on our feelings, supervisor observations, student attitudinal data, and follow-up data on graduates.

We regularly read the **Science Teacher, Science and Children, Science Activities** and **Phoenix Quarterly.**

While the program's format is established, it will continue to be evaluated and materials added and deleted based on changes in science, technology, environmental influences, and student needs. We feel that the program would benefit from more laboratory table and floor space with a stockroom of at least 200 square feet where projects could be set up.

The program could be placed on an individualized management program through the Apple II plus computer, but current plans do not include this.

Any good basic course in environmental science could provide background for the course, but the teaching methods should be established through continuing education and direct observation or videotapes of the program. Our program requires maintaining a positive attitude and hard work in spite of setbacks.

IMPLEMENTATION

The program is suitable for all high school students, both science oriented and non-science oriented. It is equally applicable to Junior College students, both science and non-science majors, or to adults in general education. A good dissemination program, for example, the National Diffusion Network, could get more teachers to use this program.

We see no major problems except that the teacher should be able to adapt this program to his own environmental setting and students should be scheduled into this science program for a minimum of 275 minutes per week.

Necessary also is a strong basic knowledge of the program, an administrative and monetary commitment, supervisor help develpment, information on other similar programs, a full commitment and knowledge of the helpful resources and people available.

For a successful program the teacher should know about land, air, water, and energy and related technological resources; have a positive and environmentally oriented attitude, and develop the difficult teaching methodology that features high student involvement and a problem based curriculum.

Both of the program developers have a number of courses related to environmental studies. The supervisor has also trained inservice teachers to incorporate aspects of environmental science and energy into the science curriculum. However, both of us feel that a basic field course in environmental education would provide teachers with enough background for this course.

Because of my work, Virginia was nominated West Virginia Teacher of the Year, the 1982 C Teacher of the Year in Southern West Virginia and named Boone County (Virginia) Teacher of the Year. The Secretary of the State of West Virgina, A. James Manchin, named her West Virginia Ambassador for Education Among All People.

Now continuing education programs offer our Environmental Science and other schools may adopt our program. We are looking forward to these adoptions and the evolution of our own program.

Chapter 5: ENERGY AND US

By

Elizabeth Horsch and Roxie Dever

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Our school is located in Casper, Wyoming, a middle to upper middle class community of 50,000 people. We are in the center of an energy producing state where the unemployment rate is low and the atmosphere is prosperous and progressive.

Kelly Walsh High School, with 1,300 students and 85 teachers in grades 10 to 12, is seventeen years old, with well-equipped science labs but no special facilities for teaching science. Outdoor environmental study areas have been provided by the Bureau of Land Management and private landowners.

"Energy and Us" developed in the fall of 1972, after a major temperature inversion occurred in the Casper area. The resulting blanket of smog was attributed in part to the emissions from the Dave Johnston Power Plant located twenty-five miles east of the city. But, a survey of students' opinions about the incident revealed how little the students knew about the production and use of electrical energy and the environmental implications of the process.

Pacific Power and Light Company, owners of the Dave Johnston Power Plant, agreed to allow students to use this power plant as a focus of study and to provide assistance with projects. Student interest in local problems and our mutual interests in creating an interdisciplinary course to answer their questions inspired us to develop a full course. We were inspired also by the many people who eagerly cooperated in this program; the personnel at the Dave Johnston Power Plant who were willing to undertake a cooperative study with students, the students who were curious and questioning, the mutual support of the teaching team, and a biology consultant who served as community facilitator. Industry, business, and the community always have been willing to work with the class as "walking textbooks." Now, students obtain information about the conversion of stored energy to electrical energy and the effects of this production on people, plants, and animals.

Students were asked to brainstorm questions about the Dave Johnston Power Plant. With student input and help, we outlined the aspects of the power plant to be studied, the "people" impacts we would examine, and related environmental factors. Then we began a community search for individuals who would help us design specific studies. In addition, as instructors, we identified background material students would need to conduct case studies.

In general, we have used this brainstorming technique to develop each year's case study. Since each study has been different, the questions, the study design, and the materials and activities vary from year to year. The common thread in design has been the use of student questions. They don't have the answers in advance and neither do we.

We learned to use our program by experimenting with it and by continually modifying it. We had to learn to work with the community, to make use of the pool of expertise afforded by our fellow teachers, and to depend on the students for many things. (Sometimes this has resulted in some rather interesting situations. One of our projects involved use of gravel. An obliging community member offered us "all the gravel we could haul," and a willing student volunteered to bring his truck to haul it. Much to our surprise and to the dismay of the gravel donor, his "truck" turned out to be a commercial dump truck!)

We had to learn to work without a textbook, to be much more flexible and responsive to student interests and abilities, and finally to develop a lot of tolerance for the unexpected. We have taught the course both in a conventional classroom with movable desks and in a chemistry lab.

The chemistry lab is conventional, but well-equipped. We also have access to the equipment in the biology department. The special equipment that we have needed, such as fumigation chambers, solar equipment, particulate collectors, etc., have been built by the students. This is one way we have individualized instruction. Often a student who did not have a lot of interest or ability in other areas is very talented at construction of equipment. We have used these talents and have relied on students to procure much of what we have needed for building materials through their jobs and through contacts their parents have.

Our school administration allows us the freedom to chose study topics, to select the materials and guest speakers, and to involve the community in our study. They cooperate in scheduling the class and our common planning period, facilitate transportation arrangements, and provide support and help if we have a problem. Without this latitude in decision-making and support, the program could not exist.

Class size has ranged from 20 to 48 juniors and seniors who reflect the socio-economic range of the general school population. We have never had a student with a physical or sensory hardicap, but we have had slow learners. A real challenge has been to discover their interests and to try to tailor some part of the activity to both interest and ability level.

OUR GOALS

Our broad general goals for science students are:

* **To develop positive attitudes toward science and its relevance to the individual, society and the environment.**

--to value science

--to recognize that science is a human endeavor

--to be aware of the beauty and orderliness of the universe
--to recognize the interaction among science, society, and technology

*** To develop and apply, through science experiences, rational and creative thought processes.**
--to use observation to investigate the environment
--to use questioning for defining problems
--to predict by use of hypothesis
--to conduct scientific inquiry
--to organize data logically
--to use experimental data to evaluate hypotheses
--to apply critical thought

*** To employ the language, tools, and materials of science for collecting, organizing, and communicating information.**
--to use appropriate mathematical skills for collecting, organizing, and communicating data
--to communicate in a scientific manner
--to use lab equipment safely and effectively

*** To acquire and apply scientific knowledge, concepts, laws, and principles to interpret the natural world.**
--to describe the nature of science

*** To use science experience as a means of fulfilling personal aspirations.**
--to participate in creative science experiments that may enhance self-concept (science projects, divergent thinking, and independent investigation)

We try to help the students reconcile their desires for an affluent lifestyle with the realities of the earth's dwindling resources. We acquaint them with alternative energy applications in our community--solar houses, wind generators, and earth-sheltered homes. Each of our case studies has dealt with science-related social issues--land use, the degradation of a natural stream by development, the pollution of the river by a poorly operated sewage treatment plant, the conflict between the mining of gravel and the development of a state park.

Students learn how to investigate actual problems that have no pre-determined answer. They learn what questions to ask, how to ask the questions, and how to use the answers to draw conclusions. Essentially the students are the researchers. They brainstorm the questions which identify the problem and define its scope. They work with us and community people to plan the study and they modify it as a result of their research.

During a land use study, the "Energy and Us" class became aware of a developer's proposal to build houses on a stabilized sand dune. Concern with the suitability of the site led to the class studying the dune's vegetation and its erosion potential. On the basis of their findings the students prepared a recommendation that high erosion potential be considered a criterion for denying a permit to subdivide, and submitted this testimony at a public hearing. Developers whose economic interest was threatened mounted an angry attack against the students. Although the students had produced a scientifically valid study and had drawn logical conclusions, they learned somewhat painfully that scientific evidence may be rejected if it is in conflict with social values or economic interests.

Sometimes students find what seems to be an obvious course of action based on scientific evidence has unacceptable social consequences. An "Energy and Us" class made this discovery after they studied an overloaded sewage treatment plant they suspected might be polluting the river above the municipal water intake. When the results of their studies confirmed their hypothesis, their immediate response was to demand that the plant be closed down. Examining the impact of that proposed solution changed their perspective; they had to face the reality of depriving several hundred households of waste disposal facilities. Human considerations had to take precedent over degradation of water quality. The appealing excitement of protest gave way to a more mature decision to work for an integrated municipal sewage disposal plan. Since students help determine the focus of the study, it is limited to their town and is relative to their world. Years when the course has not had this orientation have not been very successful.

Although instruction is not really individualized, students have considerable latitude in choosing what aspect of the study they wish to pursue. Some prefer information gathering, others enjoy interviewing or giving testimony, while others simply stand and wait. This is one aspect of the class we as instructors find somewhat disconcerting at times. In an activity-centered project like this, the lack of activity by some is painfully obvious. It is a real challenge to try to insure that all participate constructively if not equally. Our role as teachers is considerably different now that we don't identify all the problems.

Especially with field work, assignments are made to small groups or teams. The day of reckoning comes when we collect group data. Inevitably (particularly in the early stages of the study) one team or a few members of a team will fail to produce results for which they were to be responsible. The class is quick to point out their lack of cooperation. Usually a good working relationship is developed and class members learn to rely on each other and to be responsible for their particular tasks.

Our program requires a philosophy of science as a process and as a human endeavor. There is a commitment to a body of knowledge only as it applies to an interaction of technology and human welfare, and content is prescribed by the issue studied. Sometimes the philosophical commitment comes up against the realities of the teaching situation--an hour of class time which must be put to productive use.

TEACHING STRATEGIES

Teachers primarily select background materials and structure the lessons while student aides prepare lab materials.

Teaching strategies we make the most use of are:

- Brainstorming to generate questions
- Giving students responsibility for designing the study and keeping track of the data
- Allowing students a major role in drawing conclusions and in disseminating study results
- Developing a close working relationship with students and the community.

In the process you would see teachers:

- Helping small groups work on bits and pieces of the study
- Focusing student activity
- Directing lessons in background information
- Arranging for guest speakers
- Planning field trips
- Doing community public relations
- Directing lab experiments
- Searching for relevant information on a particular project.

We use many current articles relative to the topic of energy and other background materials that relate to the study project. Study guides accompany these reading materials. Activities from PEEC and BSCS that relate to energy topics are used as well. These increase student awareness. Other study materials have been adapted or developed as needed for the particular case study. We also invite guest speakers in, have students watch related television shows, and have experts work with us on-site.

A SAMPLE ACTIVITY

This is a unit on energy consumption and packaging. The activities serve as the evaluation of the students' performance.

THE CHOICE IS YOURS....OR IS IT?

Overview

Energy consumption on the scale practiced by Americans is not a matter of choosing necessities, it is a matter of being sold needs and desires. It is futile to attempt to create an energy conservation ethic without first creating an understanding of the causes of energy consumptive lifestyles.

Ideally this unit should be correlated or team taught by social studies and science teachers. The activities on techniques of persuasion could be used in social psychology, sociology, or American Problems classes. The activities on the energy cost of packaging are suitable for chemistry, environmental science, or general science classes.

Background Information - Social Studies

Analyzing choices is one step in developing critical thinking skills. Persuasion is the key word--a word that avoids the connotation of the "evils" of propaganda, or the "good" of proper education. Persuasion is a part of life; all of us are susceptible. It is dangerous to assume that only others are gullible and that our own decision-making is always rational; that we are immune to the talent of an expert persuader. After people buy a product or an idea, they defend their decision by using the slogans and images which sold them. Few people admit they are influenced by advertising, but consumer surveys and sales show that well-designed advertising has a dramatic effect.

In the lessons on packaging, you will gain some understanding of personal consumer behavior through the analysis of advertisements and packaging. Don't become defensive if the discussion of these ideas is too personal; the discovery of conflict between your values and your behavior can be emotionally threatening.

> "Other people are gullible. As a consumer I make rational decisions; I am immune to persuasion. Do you like my new hiking boots? I need them to hike across the street to my car--it might break down and I'll be prepared to walk. They're the latest style--styles are really practical these days. When I have time I am going hiking--physical fitness is important now...."

Such inconsistencies in reasoning are apparent to the reader but not necessarily to the person who said it.

In product and packaging appeal, the seller attempts to establish a pscyhological hook to attract the buyer and then appeal to him enough to sell the product. The ads are created to appeal to specific target buyers; different ads are used for the same product in different publications. The advertisements attempt first to attract attention, then establish a way the target buyer can identify with the product. If the target can picture himself in the scene, either in reality or in his dreams, then he may begin to feel he needs the product. An advertisement is not straightforward information about a product; a package is not simply a container. They both create an image. The right imagery and the right appeals can sell a person almost anything.

The artwork, photography, and design catch the target's attention. The images and use of symbols create the setting for the product. To analyze the appeal, look at the models, the background, and the atmosphere that surrounds the product. Note the clothing, furniture, location, and use of symbols (flags, symbolic jewelry, or religious symbols). Some settings imply impressive credentials for product claims: motor oil in a racetrack setting, a model in a laboratory, or medication on a counter in a hospital.

Colors

The use of color is usually even more subtle than the background or setting. Color symbolism must be considered in context with the setting and the advertising copy.

Gold or silver--indicates affluence, success, or status

Beige, navy blue, gray or subdued colors--suggest conservatism, possible affluence

Whiteness or sparkling blues and greens--imply cleanliness and freshness. Note the use of blue or white indoors and green outdoors.

Pastels--associated with softness or femininity

Black, dark red, and brown--mean masculine, dependable

Red, hotpink, and "bigcat" print designs (tiger, leopard)--
denote sexuality

Positive Appeals

Psychological hooks help create a need for specific products. This list is not complete, but represents many commonly used appeals.

Status--keeping a little ahead of the crowd. "I use the most expensive brand...because I'm worth it." "A car for people who have standards."

Fame or hero identification--The product is connected with well-known personalities who attribute their success to the use of the product.

Beauty and youth--These are frequently synonymous in our society. "Think young..." "Hands that wash dishes but look as young as her daughter's..." Many cosmetics, vitamins, and food are sold as symbols of beauty and youth.

Intellectual appeal--"The thinking man's cigarette..." "A product for people who really know about nutrition..."

Life roles--"A mother's touch..." "When dependability counts and you have to be there for any emergency..." "A father who thinks of his family's future..."

Sex appeal--The beautiful girl, handsome man, or sensuous animal appeal to our need for love or admiration from the opposite sex. "How's your love life?"

The Negative Approach

Through establishment of self-doubt, guilt or fear, this is the reverse of the positive appeals. If one does **not** buy the product, there could be loss of self-respect, peace of mind, or whatever need it is implied the product will fulfill.

Self-doubt--"My guests didn't eat very many..." "The french fries tasted greasy..." "The guests were here and my glasses had spots..."

Guilt--"The insurance was inadequate..." "Now they are left alone..." "Her tire went flat on a lonely road..."

Fear--"What if mildew grew on your shower curtain..." "Kill germs in the air...in your garbage...in your bathroom..."

Objectives

After completing the activities, students should be able to:

- Identify the image projected by an advertisement
- Identify illusions created by the size, shape, and coloring of packages;
- Demonstrate an understanding of some of the principles of imagery and illusions by creating a package and accompanying advertisement.

Activities

Activity 1: Appeal of Advertisements

Select a product advertisement and identify the source of the advertisement. Based upon the background material, develop a profile of the person to whom the advertisement is directed. To help identify the target audience of a magazine, look at the nature of the advertisement, read the magazine's own subscription advertisements or consult trade publications such as **Advertising Age** or **Journal of Advertising Research.**

Ask your teacher to give an example of a profile--both to show you what to look for and to help you select an advertisement that is not too difficult to analyze. It is also helpful in understanding the subtlety of the appeals if you share your advertisements and profiles with the rest of the class.

Example: A car advertisement, from **McCalls,** a magazine directed primarily to married women, shows a model featured as a married woman in her late 20's or early 30's. She has the "ideal" family--an older son (dark and good looking) and a younger daughter who is a carbon copy of Mom. She was a city girl who moved to the suburbs.

Practicality is illustrated by her functional clothing (slacks, low-healed shoes), her children dressed in playclothes, and the conservative colors of the house, clothing, and car. Her individuality is underscored by her self-assured pose as she is about to unload her groceries.

This is also a status appeal. Her attitude is "the cut above average." Affluence is projected by her expensive, tailored clothing and the large well-kept house, hedges, and wide driveway. She used to own a sports car and the Pacer "rides and handles like a much larger car." This is **her** car, not the family car. The car made by American Motors with the "room and ride Americans want" is parked beneath an American eagle on the porch-front of the New England "colonial" house.

Activity 2: Illusions and Deception in Packaging

Boxes and bottles: Collect a set of several different shaped boxes that are generally the same capacity. Include some exactly the same size and shape printed with different colors and designs. Collect a set of bottles and include cylindrical, conical, wasp waisted, and eliptical based shapes the same height. Set up a display of each set of containers and have students list them in rank order. Demonstrate the volume of each container and develop a list of the factors that influence your perception of the capacity of the containers.

Aerosols: Using a can of window spray (it is cheap and less volatile than other aerosols), weigh a new container. Weigh carefully a heavy duty plastic bag and spray the entire contents of the can into the plastic bag, including all the gas. Weigh the bag of liquid. Figure the weight of the can, the window cleaner, and the gas propellant. Show the class the size of a bottle that would hold that volume of liquid.

Bring in the most flagrant examples of illusions or deceptive packaging you can find. (This is a neat technique to distribute the cost among us all! Then save the best of the batch for next year's display.)

Activity 3: Ad Writing

As a team, package a drink of water (6 to 8 ounces) and write an ad for it that would appeal to a fellow student. Present your package and ad to the class. The rest of the class should be able to identify the appeal and packaging illusions.

Background Information - Science

The packaging of food and beverages is complex and includes a full range of products: wooden containers, corrugated boxes, rigid paperbound boxes, folding cartons, fiber and composite cans, molded pulp containers, paper sacks, steel-aluminum cans, collapsible tubes, aerosol cans, aluminum foil containers, preformed plastic bottles, jars, bags, plastic blister and skin packaging, glass bottles and jars.

About 58 pounds of paper, 80 pounds of glass and 1.42 pounds of steel are used each year to package the food used by each person in the United States. Smaller quantities of aluminum and plastic are used but they are more energy intensive and their use is rising each year. Throw away cans and bottles are great energy wasters.

In some highly processed and prepared food items, such as soft drink and snack foods, packaging consumes a major part of the energy costs of the food item. For example, a 16 ounce Royal Crown Cola packaged in a nonreturnable glass bottle has a content energy of 0.74 kwhr. and a container energy of 1.76 kwhr. A 12 ounce television dinner has a content energy of 2.60 kwhr. and a container energy of 1.83 kwhr.; 16 ounces of potato chips has a content energy of 3.74 kwhr. and a container energy of 4.81 kwhr.

There are opportunities for significant energy savings in this segment of the food industry. It is estimated the use of returnable beverage cans alone would save 40% of the energy currently wasted in beverage packaging.

Objectives

The student will:

- * Be able to recognize energy intensiveness of packaging
- * Be aware of the overpackaged items available for purchase
- * Be able to perform simple tests to determine the basic materials used in food packaging
- * Be able to compare the energy costs of the material used in various kinds of food packaging
- * Be able to compare the energy costs of the food packaging used in his household to the average electrical consumption of a household.

Materials

Candle or Microburner
Small metal spatula
Copy of "Energy Cost of Packaging"

ENERGY COSTS OF PACKAGING

In this study of the energy costs of packaging, we will consider the free energy of the package. The term "free energy" refers to the energy required to bring the package from its raw or natural state to its final consumer-ready form. Using a cereal box as an example, the process begins with the logging industry, moves to the saw mill, then to the paper mill, and then to a fabrication plant for boxes. From there the box is filled, stored, and marketed. Each step requires energy, and the total of this energy is what we will consider the free energy cost of the packaging.

The table below gives the free energy required to produce various containers:

Package	kwhr./container
Appliance box 12" x 12" x 8"	3.12
Folding box (140g)	1.92
Set up box, small	0.84
Milk carton (half gallon)	2.0
Molded fiber tray	0.45
Steel can (16 ounce)	1.17
Aluminum can (12 ounce pop top)	1.91
Aluminum TV dinner tray	1.74
Styrofoam tray	0.25
Polyethylene bottle (1 quart)	2.90
Polyvinylchloride bottle (1 quart)	3.90
Coke bottle, returnable (16 ounce)	2.85
Coke bottle, nonreturnable (16 ounce)	1.71
Glass bottle, returnable (half gallon)	5.18
Glass vegetable jar (16 ounce)	1.19
Polyacrylonitrile bottle (1 quart) new nonreturnable beverage type	0.98
Plastic bag (2 quart)	1.23
Paper sack (2 quart)	0.80

Activities

Activity 1

Go to the supermarket and make a list of all the ways food may be packaged. Include the raw material used in the packaging (glass, paper, aluminum). Select a particular food (potatoes, cheese, ham) and determine how many ways this particular food is packaged. Note which kind of packaging uses the most energy.

Activity 2

Save all the materials used to package the food items your household uses for a three day period. Include the packaging of food items for food purchased at fast food restaurants. Calculate the free energy costs of the food packaging collected over a three day period. Calculate this for a month and a year based on your figures.

If you know or can find out your household electrical consumption for a month, this makes an interesting and perhaps surprising comparison. (An average figure for the nation is 500 kwhr./month).

Activity 3

Discuss ways energy cost of packaging could be reduced. Studies indicate that the energy requirements for fresh, canned, frozen, and dehydrated fruits and vegetables are in the following ranges (average kwhr./lb.): fresh, 1.0; canned, 1.76; frozen, 2.53; dehydrated, 3.16. Homegrown produce varies from 0.35 to 1.0 kwhr./lb.

A can of Spam has a container energy of 6.11 kwhr./can while cottage cheese is 1174 kwhr./lb. White potatoes, homegrown, have a total energy of 0.35 kwhr./lb.; while potato chips are 8.55 kwhr./lb.

Activity 4

If a lab is available, an interesting activity to precede Activity 3 can be done. A candle or microburner and several spatulas are needed. Packaging materials, such as polyethylene, acrylonitrile, polystyrene, and polyvinyl chloride can be identified by their reaction to heat and characteristic flame and odor.

Place a small amount of the packaging material on a spatula and warm it gently in the flame. Observe whether it melts. Heat it until it burns and note the flame characteristics. Remove the flame and see if it continues to burn or is extinguished.

Compare your results to the table below for tentative identification:

Material	**Odor**	**Flame Color**	**Burns or is Extinguished**
acrylonitrile	styrene	yellow with blue base	burns
polyethylene or polypropylene	burning	yellow/blue base	burns

	candle wax		
polystyrene	styrene	yellow/blue base very smoky	burns
polyurethane	acrid	yellow/blue base	burns
polyvinyl chloride	acrid	yellow/green base*	extinguished

*gives a green color when a hot copper wire is touched to it and returned to a blue Bunsen burner flame.

OTHER ACTIVITIES

In addition to the case study each year we include units on other topics to give students a general background. The amount of emphasis and length of these units varies depending upon the time required for the case study and the relevance of the material to the case study.

* **Natural resources** (water, coal, oil, and nuclear)
  --Sources
  --Conversion process
  --Supplies
  --Distribution
  --Environmental impact of extraction and conversion to energy

* **Land Use**
  --Natural and introduced vegetation
  --Wildlife habitat
  --Ecosystems
  --Air and water quality
  --Legal aspects of land use
  --Competing interest groups involved in land use decisions

* **Energy**
  --Conservation
  --Public policy
  --Alternatives to fossil and nuclear fuels

* **Governmental process (Main emphasis on state and local levels)**
  --Formal process of political decision making
  --Factors affecting political decisions
  --Air, land, and water quality regulations

* **Personal energy consumption**
  --Transportation
  --Packaging
  --Food production
  --Personal lifestyles

* **Critical thinking**
  --Graphing and elementary statistics
  --Persuasion techniques
  --Formation and manipulation of public opinion

Former students maintain involvement with the class and class projects serving as guest speakers, providing us with information and support, and using the techniques and materials from the class in their activities. One former student sold a lamb at a 4-H sale and donated the proceeds to "Energy and Us." Another student organized a group of his buddies, prepared a fact sheet and stormed the Wyoming Legislature to lobby for a spotlighting bill. Students who have majored in such fields as environmental law, environmental biology and mining engineering indicate that "Energy and Us" sparked their interest in these careers. Indirectly, the community evaluates the program by its response to the results of the study.

EVALUATION

As instructors, we assume the major role in evaluation and in classroom management. Program evaluation is shared with the students, but we are the major evaluators of student performance. One component of evaluation is the reaction of the community to the results of the study. Students summarize and interpret what they have accomplished as they present it to the appropriate governmental body, community group or decision-making body.

We find evaluation of the individual students to be quite difficult. It seems obvious that preparing and giving testimony, writing a scientific report, or participating in a political decision represents significant student accomplishment, but we have not found a satisfactory method of quantifying this for grading purposes.

Student evaluation is based on class participation, record keeping, tests (open book--based on notebook record), and participation in out of class activities. Probably the best evaluation instrument we have is the student notebook. Students are required to keep a daily log of activities. All field data and guest speaker notes, background information, lecture notes, and study results are kept by each student in a loose-leaf notebook. This determines a significant part of their grade and is essential to the compilation of study results.

Evaluation of the program is based on student interest, response, student participation in community affairs (sharing information, political involvement), and the continuing concern and interest of students who have completed the class.

SOME STUDENT ACHIEVEMENTS

We feel the most notable student achievements in this class have been a result of their studies and their use of the results to participate in public policy decisions. They have learned that credibility requires hard work! The following is a partial list of the areas in which they have had some rather significant impact.

* Testimony before a U. S. Senate Committee on coal leasing policy

* Preparation of a fact sheet on sulfur dioxide and presentation before a Wyoming Legislative committee on changes in the Wyoming Air Quality regulations

* Input into the Natrona County Subdivision Regulations revisions

* Recommendations to the city of Casper for clean-up of the Garden Creek area

* Inclusion of the student-developed model for Energy Audits in school buildings in the state packet for energy conservation

* Recommendations to the city for bike paths

* Recommendations to the Commission of Public Lands for development of the Edness Kimball Wilkens park.

Individual or Group Awards:

* Commendation from the Casper Clean City Committee for work on the Edness Kimball Wilkens Park

* An Environmental Award from the EPA and President Reagan

* An Energy Conservation Award to a student for participation in the Natrona County School District school Energy Conservation Plan.

If you were to visit our classes, you might see students:

* Reading, discussing or viewing audiovisual material on energy-environment topics
* Working in the field
* Organizing data
* Brainstorming direction
* Building equipment
* Listening to a guest speaker
* Doing lab work
* Preparing reports.

OUR FUTURE

We view "Energy and US" as a long-term commitment to a particular attitude toward science and society. We would like to evaluate student attitudes and awareness as they enter the class and then several years later assess attitudinal changes.

Since the two of us team teach the class, we mutually evaluate the effectiveness of our instruction. The only other evaluation is whether or not students enroll in the class. Now, three percent of Kelly Walsh students enroll. We feel it is a good beginning.

Parental involvement is informal. In some cases, parents have been guest speakers or have furnished materials and expertise related to a project. Parents support student involvement by providing transportation, helping with letters and testimony, and providing information about the community.

Our principals provide a smooth-working, harmonious, up-beat school climate. Discipline problems are minor and relationships between students and teachers are good. Teachers are encouraged to pursue professional goals and excellence in teaching. The principals provide an atmosphere that is conducive to teacher and student achievement.

The only significant expense is transportation for field trips and the annual trip to the Wyoming State Legislature. This is approximately $1,000 per year. The cost per student would be $30 to $40 above the normal per pupil instructional cost of the district.

At this time we do not anticipate any major changes in program goals. We will continue to use a case study approach and address local issues.

Planning this program, contacting guest speakers, finding relevant materials, and planning field trips requires a major time commitment. A paraprofessional to assume some of these duties or an extra planning period during the school day would greatly facilitate the organization of the program. We each teach four other classes, so much out of school time must be devoted to this project.

More than materials, we need a retrieval system for identifying materials that are avilable. As an example, we need materials on solid waste and specifically the fole of bottles and cans in the solid waste stream and the energy cost of throwaways. Lacking access to a top quality library or a retrieval system, the sources of this information are not available to us.

To facilitate positive evolution of the program, teachers must maintain a good working relationship with the community, be sensitive to the interests and needs of the students, handle any disruptions with a minimum of fuss, and continue to produce study results that are scientifically valid and socially credible. As current teachers of the program, we will continue to attend workshops and conferences that relate to this type of science education.

As energy resources become more expensive and as the community responds to the stress, "Energy and Us" should continue to be a viable and useful program although the focus of the study may change. Environment per se may become less of an issue. A temperature inversion and the pollution from the Dave Johnston Power Plant gave impetus to the program; it may well be that the source of pollution in the next temperature inversion may be from wood burning fireplaces and coal furnaces.

Heaven forbid!--but if we really wanted to cause the failure of the program we would:

* Adopt a prescribed curriculum
* Split up the teaching team or remove the common planning period
* Get rid of the case-study approach or choose a study topic totally foreign to the students' interest and experience
* Adopt such a rigid set of science/social studies objectives that a flexible course such as this could not meet the criteria
* Make it a required course
* Choose a study topic that is socially and/or economically unacceptable to the community.

We have developed some overall strategies which work for us and may be useful to others who wish to establish such a program:

* Establish working relations with the community. Using the expertise of the community for information, for review of research methods and results, and for drawing conclusions increases the scope of the course and gives the class's recommendations more credibility. It also ensures a broad base of community support.

* Make a genuine commitment to openness. It's necessary to deal openly and honestly with community goals, students' values, teachers' biases, and the goals and methods of the study.

* Ensure balanced coverage of all aspects of the subject. Select speakers, articles, and methods of investigation to present as many different views as possible. (Be prepared, however, for students' finding this approach frustrating. Accustomed as they are to equations that balance and fetal pigs that have exactly four legs and no more, they will be likely to demand the "right answers.")

* Make basic good manners and courtesy a cardinal rule. Allow students great latitude in what they say, but require them to present their views with tact and consideration. (The only failsafe method of teaching this is example.)

* Avoid controversy for the sake of controversy. The project that students choose to work on must have scientific and social merit, and its aim must be reasonably attainable. If the economic or social facts of life make it futile to address the question, avoid it.

* Use established channels and participate in the formal political process. Protests and attack are far more dramatic, but if the class uses these methods the community will not take it seriously. The ability to participate effectively in the established process, in contrast, is an invaluable skill.

* Let the students' interest dictate the selection of topics. In "Energy and Us," the majority decides the direction of the study and everyone is required to participate, but any student may decline to support the group's recommendations, testimony, or position.

* Be prepared to spend vast amounts of time and energy for seemingly minimal results. A student critic said it all: "We set out to conquer the world, and only got a block from home."

A teacher must be able to work with students individually and informally and willing to learn with them--to be a facilitator rather than a dictator, to ask questions, to work in an unstructured situation, and to be sensitive to the needs of the students and the community.

The rewards we have received are a close working relationship with students, a broader understanding and knowledge of science and social issues, contact with interesting people from government, business, industry, and the community, and a sense of pride in what our students have been able to accomplish.

Awards and recognition received include:

* Pacific Power and Light awarded a teacher and a student a trip to the Thomas A. Edison Birthday Celebration in Albany, New York

* Appointment to the State Energy Conservation Committee to draft the State Energy Conservation Plan

* Appointment to the State Energy Education Advisory Board

* Selection as project writers for the PEEC

* Selection as "teacher of the year" by the Soil Conservation District

* "Energy and Us" received an Environmental Award from President Reagan.

Chapter 6: MANKIND: A BIOLOGICAL AND SOCIAL VIEW

By

Albert Orlando, Arthur Lebofsky and Wayne Browning

Clarkstown South High School
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INTRODUCTION

Clarkstown Senior High School South houses grades nine through twelve and 141 teachers, including 20 in science. The school sits on a 66 acre campus complete with a planetarium in West Nyack, New York. This conservative bedroom suburb of predominately professional people, values success through education. This emphasis on education pushes 85 percent of the student population of about 2,200 to continue their education past high school. Mostly college-bound seniors, all have taken the New York State Regents Biology course. Their attitude is serious and their participation is active. The Clarkstown Senior High School South environment, an intellectually, morally, physically, and socially stimulating environment, includes each person as a partner in the educational process to develop talents and learn responsibilities.

DEVELOPMENT OF THE COURSE

We developed "Mankind: A Biological/Social View," five years ago to meet a need identified in the lunchtime ramblings of two teachers. During the 1977-1978 school year, Wayne Browning, a biologist, and Albert Orlando, an anthropologist, provided a portion of the regular faculty lunch time entertainment with their musings. At first, they facetiously questioned each other's academic competence as they tried to demonstrate their discipline's innate superiority. However, it became obvious to observers that they were, rather, emphasizing an embarrassing lack in our school's curriculum--nowhere were students exposed to such an interdisciplinary view of the human condition. Dr. Arthur Lebofsky, Science Department Chairman, and Vincent Ferrandino, Social Studies Chairman, prodded the two adversaries to bring their philosophical debates down to earth by challenging the pair of debaters to organize into a course the basic interdisciplinary concepts they wanted students to appreciate.

In the summer of 1978, we met regularly to develop a course outline true to their original debates. In the meantime, Mr. Ferrandino worked on scheduling the team-taught course and rounding up an appropriate student population. The course was introduced that next school year with the cautious blessing of a skeptical central administrative staff. A science class called "Mankind" was paired with the existing semester elective of "Ecology." The social studies "Mankind" section was matched up so as to meet the same period as the science course and was paired with the existing one semester elective, "Sociology." The "Mankind" course was set, therefore, to open the second semester that year. This gave the cast a chance to develop materials and their approach.

During the first year's tentative operation the teachers met both apart and together with their combined enrollment of 40 pupils as they planned and attempted group activities. They experimented with various organizational plans and the two department chairmen evaluated their efforts as a team and as individuals. After that experimental year the summer produced evaluation, reconsideration and rebirth. One problem was flattering; almost 80 students had signed up for round two of the saga.

During the second year, we refined the outline, modifying it to comply with our student expectations. With a fall and spring section now in operation and Mr. Ferrandino being promoted to Assistant Principal in the school, we evaluated the courses using clinical supervision as the most useful tool. Course materials were solidified, and a library of readings and audio-visual materials evolved.

In 1982, we returned to one section of the course because two proved too great a burden for our thin resources. However, as an off-shoot of this course, Dr. Lebofsky, Mr. Browning and Mr. Ferrandino won a replication grant for a course, "Decision Making: Ethical Issues," which Mr. Browning currently teaches. Dr. Lebofsky has teamed this year to teach the "Mankind" course with Dr. Orlando.

The science supervisor was instrumental in the development efforts, and we needed little administrative support. Since we developed and taught the course, we planned no staff development. However, since we began team teaching other courses have developed around the philosophy such as courses in decision-making skills in the science department to mesh with the "Mankind" elective. The only other people involved were guest speakers from the community and staff.

There is nothing unusual in the traditional classrooms we use. We have 45 movable seats and desks and frequently rearrange furniture as befits the activity. We feel this flexibility of seating is crucial and the four large bulletin boards and plentiful chalkboard spaces are helpful. One unusual feature is the television studio in the school we use for video taping.

COURSE DESCRIPTION

New York State requires one year of any science, however, up to 75 percent of our seniors enroll for one or more science courses as follows: 55 percent enroll in physics, 10 percent in earth science, 99 percent in biology, 85 percent in chemistry, and 10 percent in AP sciences. The State Regents, which issue a general syllabus as a guide, requires 30 lab activities in a Regents course and provides some standardized tests. Otherwise, teachers have autonomy in their planning, instruction and evaluations.

Our district's science curriculum calls for courses and activities designed to allow the individual student to interact with science as a discipline and to experience objective inquiry as a method of investigation. Emphasis is placed on the processes of science so that students can verify and interpret scientific knowledge, develop positive attitudes and interests related to science and scientists, and recognize that these behaviors can be applied in making decisions in an age influenced by science and technology. The curriculum requires that instruction reflect the nature of science and the needs of the learner. This is to be stimulated through the use of the laboratory and demonostrations as focal points, and opportunities for students to apply scientific methods and knowledge to formulate possible solutions for societal problems. Our district also emphasizes motivating students to continue their study of science.

Within this framework, we organized our course **Mankind: A Biological Social View** around five themes:

THEME	KITS AND ACTIVITIES	BIBLIOGRAPHY
Humankind & Society Man and Culture Animal Society Human Society Role of Environment	Kit: "How Life Survives: Adaptation & Evolution" Videotape: "Ladder of Creation Speakers: Creationist's View Slide Series: Illustration of Primate Evolution Activity: Develop "visual" evolutionary scale	Hardin, G. **Population, Evolution, and Birth Control** McDonald, M. **The Origin of Johnny** Adams, P. "The Origin of Cities" Lannings, E. **Peru Before the Incas** Lewin and Leaky, **Origins** Devore, I. **Primate Behavior** Buettner-Janusch, J. **Origins of Man** Simons, E. **Primate Evolution** Wolf, E. **Peasants**
Order in Man's World Biological Order Social Order Aesthetic Order	Filmstrip: "The Code of Life" Videotape: "World Within World and Generation Upon Generation"	Time Life Books.**The Emergence of Man** Pearson, R. **Introduction to Anthropology** Mair, L. **Marriage**

		Bendix and Lipset, **Class Status and Power** Gerth and Mills, "Bureaucracy"
Reality of Disorder Biological Disorder Social Disorder	Overlays: "Illustrations of Mutations" Lab: "Camouflage and Natural Selection"	Calhoun, J. "Population Density and SOocial Pathology" Rosenfeld, A. "Prolongevity" McHarg, I. "Design with Nature"
	Filmstrips: "Aging," "Searching for "Immortality" Film: "Multiply and Subdue the Earth" Activity: "Designing a Living Complex"	American Friends Service Committee, **Peace in Vietnam** Arendt, H. **The Origins of Totalitarianism** Beatty and Johnson, **Heritage of Western Civilization** Rustin, B. **From Protest to Politics** Lenski, G. **Power and Privilege** Montegue, A. **The Nature of Human Aggression**
Technology & Humankind Prehistory Agricultural Revolution Industrial Revolution 20th Century and the Technocratic Society Individual Rights vs. Technology Can Humankind and Nature Co-exist? Struggle for Energy Struggle to Feed the World Acceleration of Scientific Knowledge	Asimov, I. "The Nightmare "Abortion," "Nuclear Power" Senate Hearing: "Down's Syndrome and Sterilization" Song Analysis: "In the Year 2525" Kits: "Four Biomedical Case Studies," "Energy: Human Issues," "Food: Will There Be Enough?" "World of the Future, Control of Life" Simulation: "Redwood Controversy"	Debates: "SST," of Life Without Fuels" Slater, P. **The Pursuit of Loneliness** Toffler, A. **Future Shock** Foster, G. "Peasant Society and the Image of Limited Good"
Change & the Future of Humankind Birth and Life Death and Dying Prolonging Life Extra-terrestrial Life	Activities: "How Large is a Billion?" "Legally Dead" Kits: "The Science and Ethics of Population Control," "Redesigning Man," "Four Biomedical Case Studies," "Aging,"	Brown, et. al., "22 Aspects of the Population Problem" Time. "The Age of the Miracle Chips" Abbott, W. "Work in the Year 2001"

"Transplants"
Speakers: Terminally Ill,
Undertaker
Simulation: "Who Should
Get the Transplant?"

Our department and school's commitment to human welfare and progress is the very reason for this program's development.

INSTRUCTION AND EVALUATION

We have woven an emphasis on science-related social problems and issues and the related decision-making throughout the curriculum outline, especially in Unit IV, Technology and Humankind. We stress inquiry processes by requiring an original research paper from each student.

During instruction we present all sides of issues as, for example, in our evolution/creation/thermodynamics debate in Unit I. The problem-centered curriculum has some flexibility to respond to the class interests and term papers chosen each term. The central focus on humankind is obvious from the course title: "Mankind: A Biological/Social View." While global in scope, we involve local resources for research papers and guest speakers. The problems we study come from the natural environment because they are the ones that will affect the future of students. We often organize instruction around small group discussion sessions in which teachers move about to assist the groups activities and decision making. Rarely do we individualize instruction except to aid with research projects.

TEACHERS

Our teachers must adopt many roles: interventionist, facilitator, group leader, bureaucratic leader, lecturer, inquisitor, role model. We avoid telling or lecturing for longer than 15 minutes, imposing out will, being dogmatic, and closing off student questions or debate. We use a collection of printed material that varies from year to year due to the changes in technology and society. Two texts we refer to continually are Bronowski's **Ascent of Man** and the **Origins of Johnny** by MacDonald.

We meet five periods a week for 43 minutes sometimes with the two classes meeting together with new sub-divisions of groupings. In the process, our course spans the evolution of life on earth through hominoid evolution, the assesses order and disorder in our current society. We analyze technology and its impact and attempt to predict the future. We also frequently show and discuss video tapes such as the "Life on Earth" series. Speakers often present ideas on genetics, architecture, creationism, and thermodynamics.

Student activities include taking notes, asking/answering questions, viewing audiovisual materials, listening and giving oral reports, leading discussions, role playing in groups, defending a viewpoint, developing a model of an otherwise complex concept, baiting the teachers, and other more routine behaviors.

We evaluate rational decision-making using Kohlberg's model and Rest's "Defining Issues Test." Our current evaluation includes some formal interviews with past graduates; no other longitudinal assessment seems adequate. While students are not involved in planning lessons, we do ask them for a summary evaluation of the course and our teacher team. We do not attempt to measure student achievement by standardized tests, nor do we care about such scores. Some of the best students (such as this year's valadictorian) enroll in our class, and in these students we notice growth in decision-making skills from the Rest Test when we compare pre- and post-test data. Mid-term and final tests are often put together as a team.

We often evaluate our teaching in daily meetings by clinical analysis of objectives and success in meeting them. We feel our evaluation data supports our goals.

Our administrators provide academic autonomy within a positive disciplinary framework in the school so classes are not disturbed. We base educational decisions on test data, mutual needs assessments and goal evaluation. The department chairman makes specific decisions about the budget while evaluation decisions fall under board and union jurisdiction. Teachers and department chairman perform the planning and program development. The audiovisual coordinator, particulary supportive, helps us obtain, schedule, and use materials. The television studio directo also assists us in using video taping for analysis or evaluation.

Minimal expenses connected with our course include some duplicating costs and the initial costs for materials such as texts and magazines. Professional organizations have provided little help however, articles from journals related to evolution and the integration of sciences and humanities provided a philosophical and factual base.

OUR FUTURE

Our program goals have remained stable, but the evolution of our program reflects changes in society and technology that affect our students. The annual anonymous student course evaluations keep our program relevant and attractive. We need larger rooms, more flexible seating patterns, easier access to the audiovisual hardware, additional audiovisual equipment, and more chairs and desks. To improve our program, we would like to increase student involvement even more and update some activities to make courses more participatory, interesting, and valid for our pupils. Our planning could be improved by more flexibility in scheduling which would allow more students to elect the program. We have considered adding computer simulation activities to allow us to develop models and concepts difficult to describe otherwise. To improve administrative support we would recommend visits so they might offer suggestions based on their experiences. Their continued encouragement is important. In future budgets we have included funds to update printed material, acquire computer programs and audiovisual materials, and visit other sites to view similar efforts to help us generate new ideas.

We LET our program evolve naturally by trying to match our students' needs. We do not attempt to plan the evolution, yet we think it will grow in popularity. This increasing diversity will challenge us to develop our resources and refine our expectations of students. For our lab science classes we would like seven or eight periods scheduled each week on a rotating six-day cycle. For the non-lab classes we would recommend five days per week on a six-day cycle.

DISSEMINATION

We have spoken at several conferences (NABT, THE Conference, NYSSSA, Iona College, etc.), but always at our own expense. We would love to further share our ideas but can't afford the expense.

To establish their own program, teachers should attend our workshops and view our videotapes. Our program requires a love of children coupled with a love of teaching meaning the ability to communicate, to be non-defensive, and to help direct or, better yet, to facilitate student work efforts. In addition, teachers must have background in biology, anthropology, or sociology. Critical to successful instruction is decision-making and critical analysis skills by teachers who are receptive, sharing, caring, and helping. Such teaching rewards teachers with the unique opportunity to share with a colleague and a class significant thinking about the common future. We received some recognition from the state and national SESE award; invitations to NABT, THE (Toward Humanizing Education), and New York State Science Supervisors Association conferences; and invitations to speak at Iona College and at nearby districts.

Developing our program has been a labor of love. And, like all love affairs, has had its high and low points. We hope you will be as excited by the possibilities as we are and that you can use some of our ides and explorations in your own program's evolution.

Chapter 7: WALLINGFORD AUDITING TECHNICAL TEAM

By

Carol A. Wilson

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Wallingford, Connecticut, a blue collar community of 36,000 people, many descended from Polish immigrants or early British settlers, is over 300 years old. We are proud of our history and maintain an attitude of independence and self-sufficiency. However, in spite of a large industrial base of diverse industries, like many towns of the Northeast it is shrinking.

Dr. Mark T. Sheehan High School, built in 1972, has 1,100 students in grades 9 through 12 and 75 enthusiastic faculty who willingly devote extra time to students. For their science requirements, all freshmen must take Earth Science and all sophomores, biology. Half the students also register for chemistry and one quarter register for physics.

The extracurricular Wallingford Auditing Technical Team (WATT) program grew out of my classroom energy study. Now, I meet with ten to twenty students from 2:00 to 3:30 on Thursdays for a voluntary program which costs the school nothing. All materials are free from state agencies or the town. This is the Wallingford Auditing Technical Team (WATT) which studies energy waste in the school and community.

WATT really began ten years ago when I took a graduate course, "Earth Resources," taught by Thomas Williams at Wesleyan University and attended a program on school energy management established in Lee County, Florida at the NSTA sponsored First Energy Education Practitioners' Conference. These two programs inspired me to prepare my students for energy changes and decisions. After I began teaching a unit on energy resources, world events reinforced and strengthened its impact and my commitment. I believed energy was one of the most important topics my students would study, and I told them so. My students became so concerned that they wanted to do more than just learn about it. So, we formed WATT to study and reduce energy waste in the schools.

We adapted an empty classroom to suit our needs and used it as a meeting place. Ed Pratt, an engineer in the Connecticut Department of Public Works, heard of my interest and offered to teach us how to do energy audits. After two hours, we thought we knew how and attempted a huge audit of a middle school. We wound up spending hundreds of hours and learning much during that audit. We presented the school board with our findings and they were impressed enough to appoint us an "Energy Management Committee" with Larry Mrzowski, our custodian, as Energy Conservation Officer. Together we made many recommendations which Mr. Mrzowski then implemented. At the end of the year, I dug out the energy use figures for that year and the previous four. To my amazement we had saved the district over $260,000 in energy costs.

The Schools and Hospitals Program, administered by the State Energy Division of the Office of Policy and Management now certifies our students as energy auditors and pays for audits of schools and municipal buildings. Of the 15 WATT memebers who took the state auditor certification test, designed for adults with building management experience, 14 passed. Having been certified energy auditors we then were hired by the town to audit all 18 municipal buildings and the rest of the schools.

Al Cei, Supervisor of Buildings and Grounds, and a strong disbeliever, tried our suggestions and became an enthusiastic supporter. Our principal is generous with praise and time off so we have studied energy use in a variety of town buildings: the Senior Citizens center, The Electric Division Office, the Sewage Treatment Plant, churches, the YMCA, homes, and businesses. We rely on the community for technical help and in turn we respond to their requests for information. Teachers support our program because students' skills improve so much, especially in mathematics and communication. Parents and the school administration provide moral support as well.

We also are supported through audit forms and reference materials supplied by the Schools and Hospitals program and the Connecticut Energy Division. We developed our own audit form, but the Energy Offices can also supply free Preliminary Energy Audit and Energy Audit forms to anyone who requests them. We have a burner test kit on loan from the town.

OUR GOALS

WATT members tend to be high ability students and, although some join to gain job skills and to make a significant contributions, the heavy demands weed out all but the most committed.

WATT's goals for students are:

- To see the everyday relevance of science
- To appreciate the interaction of science with history, technology, economics, and other areas
- To be aware of the impact of science on our standard of living
- To understand scientists responsibility for the environment
- To be aware of career and vocational opportunities in the sciences.

WATT students learn about energy problems, work to solve some of these problems; and consider alternative futures to plan for the best. Students learn choices cause social problems (economic hardship, loss of jobs) and solve others (by cleaning the air, making technological solutions better understood). Energy conservation involves value judgements that are not only economic, but also ethical and moral. Future generations and people in third world nations should share in the "good life."

Future energy choices having immediate and long-term impact on the environment must be based on sound scientific principles and consideration of social issues. I find the commitment to human welfare motivates the students to learn the scientific principles. Much conservation depends on the physical laws of flow or thermodynamics, which are part of the content of this course. Students also use mathematical formulas and scientific notation.

Besides learning and applying scientific principles and considering the economic and social effects of decisions, WATT members have learned to interact with others for the good of the community, such as with town officials and teachers, to gather energy data and to recommend more efficient ways to use energy. Our WATT students also work with younger students and learn to work together, teaching one another how to solve problems by selecting their own tasks in groups of 5 or 6.

In WATT, students and teacher democratically manage decision-making and planning frequently more than is possible to accomplish. But our failures also teach them and occasionally I tempt them to try more than they have done before. Ususally they succeed, gaining confidence and experience for the next step. The help WATT gives students in expanding their abilities was reflected in one member who was math anxious in 9th grade. As a senior, she earned "A's" in Calculus and college credit as well. My students can speak to large groups of their peers or adults. They can advise people of any age on energy conservation, speaking from a wealth of experience and knowledge. In 1982, they were honored as the National Energy Conservation Coalition "Program of the Year," received the Principal's Award, and were the Connecticut winners of the Century 3 award.

As the program instructor, I plan and teach all the lessons; prepare laboratory materials with the assistance of student aids; and evaluate the students, the program, and myself. In the course of a week, if I'm not involved in an energy audit, I'm taking phone calls to arrange audits, helping students solve tough math problems, testing new equipment, or typing completed audits.

The Energy Lesson from which the entire WATT program developed gives an idea of the course activities and planning. First students receive a research assignment by choosing an energy source. Next they find answers to these basic questions.

* How much of this energy source remains and where is it located?
* How do we get it?
* What are the environmental problems associated with obtaining and using this source of energy?
* How fast are we using it?
* How long will it last?
* What else could we do with it if we didn't burn it?

Students then make oral reports, limited to one period per topic. We begin with natural gas and oil then coal, nuclear fission, and renewable energy sources. Finally, we study conservations. Students find simple solutions vanish when all aspects are considered. At the end of the unit, students use their findings to write letters to those in positions to affect energy use. Finally, students also do energy audits of their own homes passing on recommendations to their parents.

EVALUATION

We evaluate our program by the energy saved and by the awareness we create within the community. In two years WATT saved approximately 400,000 gallons of oil and over 3 million kilowatt-hours of electricity in a community that is now energy conscious. The new library is 30 percent solar heated, and the governor has cited five local companies (of 40 cited in the state) for energy conservation. In spite of all we already accomplished, we'll never run out of buildings to audit or people interested in ways to save energy. Last summer, at their request, we audited small business and now have begun home auditing.

OUR FUTURE

Much work is available and time is our biggest problem. Ideally, I would like more time available during the day to work on WATT projects, particulary making phone calls and meeting with students. The school board could assist by allowing us time to train teachers and students with students receiving course credit and the teachers either being paid for directing WATT or receiving compensatory release time.

I would like to see WATT offered during the school day with course credit for students and open to adults seeking vocational training. But, it will probably remain extracurricular, gaining adult members who could perform the home audits during the school year.

Finally, to see similar groups develop in high schools throughout Connecticut and the country, we have presented programs about WATT to other school systems. These new programs have started because teachers are willing to give up the time to make it work, though many have encountered the same difficulties we did. We now have a videotape on WATT for dissemination.

Now that WATT is established it seems to have a life of its own, and I would not change much of this program if I were to establish it at another school. Three elements seem vital; school board involvement, student motivation, and participation in decision making. And, we also need help from experts in the community such as architects, builders, and engineers to teach us how to read blueprints and analyze buildings and utility people to teach us how to do energy audits. The first audit in a new program should not be a complex building (such as a school). A fire station or a library, for instance, would be simpler.

Teachers in this program should have good math skills and respect for the abilites of teenagers, a willingness to let students try things they might not be able to do at first, a knowledge of physics, a background in energy souces, a concern for the enviornment, and a belief that energy is an important concern for students.

AND WHAT WERE MY REWARDS?

For developing this program I received the NSTA "Star" Award; the Connecticut Science Teacher of the Year Award--Sigma Xi, 1981; the Connecticut Conservation Teacher of the Year Award, 1981; the Grange Community Service Award, 1982; and the National Energy Conservation Coalition "Program of the Year" Award, 1982. But, most of all this program has provided pleasure in working with the students, respect from the community and professional recognition. Conservation works, and individuals can take positive steps toward solving an important problem while educating our students for the future.

Chapter 8: SCIENCE/MATHEMATICS/COMPUTER MAGNET SCHOOL

By

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Gompers Secondary School, part of the San Diego Unified School District, serves the southeast section of the city, a lower socio-economic area of predominately Black, Hispanic and Asian population. Five years ago, because it was shrinking and 99% minority, it was identified as one of 23 minority, isolated schools to be integrated under Court order. A voluntary or magnet program was chosen because we hoped that instituting a technology-oriented magnet school would attract non-minority students from other areas of the San Diego Unified School District. Gompers' selection as a math/science magnet at the secondary level drew inspiration from numerous research facilities in the area (for example, Salk Institute) and educational institutions with their associated research components (for example, UCSD Medical School), as well as technology-oriented industries (Hewlett-Packard, Sony, etc.), in addition to the military, government, and aerospace industries in the greater San Diego area. A Science Advisory Committee of 39 representatives from those local scientific organizations and 43 people from within City Schools and the Chairman, Mr. Serafino Guiliani, a retired Science Specialist for San Diego city Schools, outlined and guided the program implementation from facility remodeling through curriculum development. This produced a curriculum featuring math, science, and computers as well as the regular junior high program serving Grades seven and eight. The curriculum includes Astronomy and Space Science, Experimental Design, Government in Space, Medical Biology, and Computer Design and Structure. Also offered are the usual courses such as English/Literature, Fine & Practical Arts, Russian, Spanish, German, and so on.

Of the 960 students in grades 7 through 12, 620 currently are in the magnet program and 340 are in the resident junior high program (Grades 7 and 8 only). Fifty-eight classroom teachers, three resource teachers, counselors, and administration staff the typical California style building. The 30 year-old plant with outdoor hallways in a single story was upgraded with a special plant/animal house, environmental pond and area, and new physics, chemistry, and biology labs with specialized equipment.

STAFF

A screening panel selected staff members for their teaching expertise and commitment to integration, as well as their ability to work well with students of various ethnic backgrounds. The "new" magnet teachers developed the proposed course curriculum while the Science Advisory Committee supervised the facility remodeling program with the District. A community awareness program, coordinated by a resource teacher, began alerting the community to the virtues and offerings of the magnet. To smoothly implement such a radical change, only Grades 9 and 10 were offered for the first year.

The San Diego Unified School District School Board, Superintendent, and his line staff designated the magnet school program as the Number 1 priority in the district (even in the aftermath of the failure of the famous California Proposition #13), were able to honor all reasonable requests for equipment and supplies.

The Gompers staff works cooperatively with the San Diego State University Education program. Presently, student teachers and teacher aides assist in classroom instruction, which further reduces student/adult ratios and increases individual attention in many classes. Teachers with strengths in a technology-oriented academic curriculum, after hiring, were given in-service programs covering the unique features of the magnet by the site principal and magnet coordinator in weekly magnet meetings.

Larger-than-normal classrooms of various shapes and sizes with pleasing yellow walls and darkening drapes, teakwood cabinets, black hard surface counter tops, blue chairs, light grey floors, have modular hexagonal islands with drafting-style swivel stools for the physics, chemistry, biology, and general science rooms. Ample cupboards, cabinets, drawers, and closets store and display apparatus.

Numerous attached rooms provide unique space for for small-group instruction, teacher workrooms, equipment/lab setup, housing for specialized equipment (laser/holography, darkroom, plant/animal house, storerooms, etc.). Specialized areas developed for computer use provide ample counter space, and air conditioning for the mini-computer.

Our equipment includes items such as:

- DEC PDP 11/50 Computer System with 32 terminals with MAGTAPE subsystem
- Laser/Holography Apparatus
- Celestron "8" Telescope
- Microscopes/Phase Contrast
- Programmable Calculators
- 30 Microcomputers
- Laser Videodisc System
- Torbal and Analytical Balances
- Spectrometer
- Spectrophotometer
- Oscilloscopes
- Micro-wave systems
- Stroboscope
- Graphics/Plotter Terminal

Ample storage space provides security with allowances for future acquisition of apparatus and materials, and all chemicals are housed in a special safety-designed and ventilated store room. Instructors, teacher assistants, and assigned student monitors coordinate student clean-up procedures. Students have access only to specific laboratory apparatus in which they have had prior usage instruction.

CURRICULUM

While classes are limited to 25 students with similar career interests and attitudes, the magnet program is available to **all** interested Grade 7-12 students, without entrance or placement examination.

The exceptional opportunities offered in science, mathematics, computers and health care include the computer science program which emphasizes the study of computers as tools in mathematics, science, and health courses by utilizing such languages as BASIC, FORTRAN IV, PASCAL, and MACRO-ASSEMBLER. Students undertake individual research projects, use the environmental study area, plant and animal laboratories, freshwater pond, and the experimental garden. Integration of computer sciences in biology, chemistry and physics offer traditional subjects correlated to modern functions.

Electives include geology, medical biology, space science and astronomy. Students study current energy and environmental issues and learn the use of computers in scientific research and health care. Complete programs in English, social studies, physical education, Spanish, German, Russian, as well as other electives balance the technical curriculum.

In the seventh and eighth grade, the courses titled Math, Science, Calculator Math, and Computer Science are required. In ninth grade, students must take Experimental Design. In grades 10-12 a minimum of two years of science are required, most students take three. Students generally study Physics in 10th grade and Chemistry in 11th grade. Medical Biology, Honors Biology, Honors Physics or Astronomy and Space Science are other electives. All students take Biology, Chemistry and Physics, while about 5% take Astronomy/Space Science. Our mathematics and computer curriculum has no grade-level designations, so students are programmed according to ability. Most students are scheduled into at least one science course which meets daily.

Students explore many possibilities through simulated living in unusual environments and through participation in competitions such as the Space Shuttle Student Involvement Project and the Greater San Diego Science and Engineering Fair. These activities express a key curricular component, learning to adapt to change. Field trips, guest speakers, or course-related study present the pros and cons of science/society-related issues such as nuclear energy, recombinant DNA, acid rain, gerontology, and other topics. In several classes, students participate in role playing, experiencing the problems and anxieties resulting from decision making. Outside guest speakers represent diverse technology- related occupations and, wherever practicable, current social problems and ethnic contributions are used in the curriculum with emphasis on the relationship between humans and society/science in the evolution and advancement of the human race.

Students explore not only the world influence, but also their own community, through participation in the Marine Floating Laboratory, Wild Animal Park, Whale Watching Trips, Silverwood Botanical Reserve, and the San Diego Zoo.

Small class size, through teacher assistants, instructional aides, and community volunteers, permits much one-to-one contact with students. Students also work together in small seminar groups on course work, investigation of immediate, local, or national problems, or long-term joint projects. Role-playing, debates, small group seminars, as well as large group situations, reinforce decision-making skills. Subjective open-ended essay questions, rather than objective tests, assess students application of basic knowledge to new situations.

Specially selected Master Teachers, through a wholistic approach, prepare young people for the world of the future. The structure of the intellect model is emphasized throughout all curriculum areas. The teachers as facilitators either wrote the curriculum or adapted one currently available to our unique program in the decision-making and lesson planning process. Classroom management is the responsibility of everyone in the class, not just the teacher. This is emphasized from the first day of classes.

Half of our senior class will graduate with a G.P.A. of 3.5 or better. The third year senior class of only 19 students produced one National Merit Finalist and one Commended Scholar. In the junior class of approximately 65, four or five students should qualify for National Merit next year based on latest test score requirements. Two Gompers students were selected from all of San Diego County to have their projects evaluated for the Space Shuttle Contest. If selected, the student experiments will be conducted on the Space Shuttle during its flight. In 1979-80, 46 students entered 41 projects in the Greater San Diego Science and Engineering Fair, winning 48 awards. Of the 130 student projects of 1980-81, 48 were accepted for entry in the 1981 Greater Science and Engineering Fair. A 10th grader won the Junior Science & Humanities Symposium in 1980 and presented his project at West Point during the summer. Three students entered the AED National Computer Contest and two entered the Westinghouse National Science Talent Search. A Gompers' student was one of fifteen semi-finalists for the national Thomas Edison/Max MacGraw Scholarship. On two occasions Gompers' students presented science projects to the National Consortium for Black Professional Development. A Gompers Instructor was one of 100 educators and scientists invited to view the pictures being transmitted by Voyager from Jupiter at Jet Propulsion Laboratory. And, a Gomper's Instructor lectured on Saturn at the World Congress on Aerospace Education in Amsterdam, Holland, during summer 1981.

Our students have conducted research at the medical lab at UCSD, the Scripps Institute, the Salk Institute of Biological Science, the laser laboratory at San Diego State University, the Naval Ocean Systems Center, and at UCLA on topics such as medical diagnosis by computer, cancerous tumors in mice and computer research.

Sixteen of our third year graduating class won a total of $130,374 in scholarships and grants. The ensuing Senior class produced three National Meet Finalists, six commended students and an increase in college and university scholarships.

For informal evaluation, we use standardized test scores, college placements, scholarships, and much self-evaluation. Also, a district integration monitoring/evaluating team aides in evaluation.

Teachers design the evaluation tools and methods by which students receive regular A-F scale course grades. The required Stull Bill evaluation allows teachers to adapt the criteria to their teaching objectives. In addition, parents often serve as a source for informal evaluation and planning resources.

The large waiting list of students suggests that we should expand. However, maintaining the same quality is a prerequisite. The waiting list indicates our popularity as a magnet school.

From the success at Gompers, it appears other magnet schools will develop corollary science and math programs in such areas as medicine and health or aeronautics and engineering. Public demand may force continued expansion of the math/science specialty school or face alienating the public.

Our teacher education continues to be district sponsored, covering such topics as Computer Awareness, Race/Human Relations, Oral communication, Specialized and gifted programs, and energy conservation. While no out-of-district travel is allowed we encourage teacher participation in conferences, seminars and workshops whenever possible.

As is always the case, our district and county education centers provide in-service training for teachers with the largest area of need being computer expertise. Since we attempt to attract students from all parts of the city, the district must bear significant transportation expenses. Maintaining and operating our extensive computer and science resources also is a major expense. Two resource teachers currently coordinate the overall program, budget, transportation, public relations, recruitment/enrollment, counseling, tutorial programs, community contacts, liaison with district integration programs, discipline, supervision, ordering and repairing of equipment and supplies, home visitations, and field trips. Numerous instructional aides support a lab-oriented science program. Our first and obvious task, to integrate the school, we did with numbers, but we must continue to work for positive race/human relations in all aspects of our school. As a magnet school in a technological area, we are, by definition, charged with creating and maintaining a relevant and attractive program. We receive the fiscal support to maintain our popularity.

Three critical components of success in our program are small class size, adequate supply/maintenance budgets and free transportation.

To generate a program such as ours requires that a key person gain exposure to other exemplary programs and obtain support from the community, district (central staff) and Board of Education. Educational programs concerned with advanced computer technology requires continuing staff training to keep teachers in touch with the latest developments, e.g., through such organizations as NASA. Teachers in our program must be totally dedicated and committed to the program, have a giving attitude, and not be intimidated by high-achieving students. They must be able to work with people of all backgrounds, have considerable computer and math abilities, and be able to provide interdisciplinary integration, i.e., a holistic approach to education. The rewards of teaching in our program come from meeting the needs of high-achieving students and assisting them to attain their goals, awards, recognition, and the national recognition our program has received. Also significant is the creativity made possible by central and site staff assistance and the fiscal support of the district. Most of our teachers' recognition has been through their students' achievements, honors, scholarships, and awards.

Chapter 9: CONTEMPORARY ISSUES IN SCIENCE

By

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The **Contemporary Issues in Science** Program (**CIIS**) developed from our belief that today's youth cannot afford to ignore the rapid technological advances of modern society. The program is flexible and can be tailored to meet the individual needs of a class, a school, or a group of schools. The **CIIS** program is a unique opportunity for students to view science as a vibrant reality constantly changing the world in which we live. Thinking and working with the issues of the day, students develop not only an understanding and appreciation of science content and process, but also a social awareness of the ramifications.

CIIS offers classroom discussion enriched by a series of guest lecturers from the scientific, industrial and political communities who meet with students to provide them with additional perspectives on the issues. Students prepare research papers on current topics which impact on their personal lives. Scientists and educators review the completed research papers to offer constructive suggestions. At the conclusion of the research, class discussions, and lectures, **CIIS** students share their ideas in group panels with scientists, business representatives, community members, parents, and other students in a full day Science Forum.

Susan E. Wagner and New Dorp High School are located roughly in the center of Staten Island, "the forgotten borough" of New York City. This island of over 250,000 people is a largely middle class community which has been growing rapidly since the Verrazzano Bridge was built in 1964 connecting the island with Brooklyn.

Both high schools, conceived as comprehensive public schools, offer academic, business, and technical courses of study. Each has approximately 2,500 students who come from a cross section of socio-economic backgrounds. In recent years the school policy in both schools has been to give every student a full program of classes.

OBJECTIVES

An extensive 6 year trial provided resource personnel, institutional support, data, scientific background, and pedagogical experience necessary for designing an effective yet flexible local model for bringing students in grades 10-12 to a working understanding of the relevance of technological advances and the impact of those advances on society.

The Science Forum program, unique since it answers a critical need in science education through the development of a practical model, is flexible and readily adaptable to any class, school, or system of schools. The three components, **curriculum,** the **lectures,** and the **Science Forum,** can be tailored to individual needs with ample consideration of financial constraints, personnel requirements, student profiles, and school organization.

1. **Course.** The entire curriculum can be adopted by a school as a full year course within the science curriculu, in grades 10 through 12 and adjusted for the average science student or for the gifted/talented. In some cases it may be used to fill the need for a second level science course consistent with current practice throughout the United States or may be adapted to the humanities or social studies curricula through the communication, writing, and political/economic components.

Select portions of the curriculum may be used to enrich existing science syllabi, including biology, chemistry, and physics by adopting the class discussion and research paper only.

2. **Lecture Series.** Since the use of guest lectures is important, schools may contract lecturers although available personnel from local universities and institutions are less costly.

3. **Science Forum.** The forum may consist of one class and invited guest held within the school or multiple classes within a school can participate in a forum. Multiple schools using outside facilities would require a coordinator to organize the schools within the framework of the curriculum and the forum.

PROGRAM FOCUS

How important is it for today's youth to explore the issues of technology that surround us all? What impact will dumping hazardous waste materials have on their future and their children's future? How will the use of carcinogens in food ultimately affect their lives? Do they have the right to be concerned with the questions and implications of acid rain, genetic engineering, and nuclear energy?

"Contemporary Issues in Science" (CIIS) developed from a belief that our youth have a large stake in the future of our country and the world. But to be able to deal effectively with them, our young people need independent reserch skills developed through discussion with knowledgeable experts in the field; evaluation of what they see, hear and read; and formulation of their own opinions based on risk/benefit assessments.

The **CIIS** program, for advanced classes, either enriches existing curricula (biology, chemistry, and physics) or serves as a separate elective course in science or social studies. This flexibility permits teachers to use various elements of the **CIIS** program in average science or social studies classes. **The Course Manual** details primary goals; specifies isssues with questions for each topic, identifies research tools, and provides procedures for discussion groups.

The versatility of the program allows for several approaches ranging from the smallest, a program carried out within one classroom, to a program that includes students from two or more classes researching and discussing the same issues. Sharing ideas with pupils from other classes brings relevancy to complex social issues and provides greater breadth. The most effective program involves classes from different schools but requires a coordinated effort among teachers and supervisors from the various schools.

ESSENTIAL CHARACTERISTICS OF THE CIIS PROGRAM

The **CIIS** program consists of class discussions, student research, lectures, and a forum. Stressing pedagogical principles of objectivity and structure, this approach to complex issues stresses objective data, concepts, and ideas that underlie issues by drawing on many viewpoints. Students follow an analysis of the issues in a highly structured program which includes: preparing and writing research papers; specific deadlines for completing reference searches, outlines, and final submissions; carefully selected issues with specific questions; broad based support for research through library work, lectures, interaction with the community, and scientists' reviews of research papers; and class discussion groups centered on definite goals and questions.

CLASS DISCUSSIONS

At the beginning of the term, students are presented with several contemporary scientific issues. After student discussion, each student selects a particular issue for research (the teacher assures equal distribution). Some current and critical issues from recent programs include: Energy and Living Standards; Cloning; Genetic Mutation; Science, Society, and the Media; Laetrile; Solid Waste Disposal; Carcinogens; Human Experimentation; Nuclear Energy; Recombinant DNA; Solar Energy; Coal Extraction and Utilization; Hazardous Waste; Love Canal; Acid Rain; Radioactive Waste; and Aquifers.

STUDENT RESEARCH

Tomorrow's decisions are based on today's experiences, and the research paper trains students to carefully consider all sides to a current issue. Each student receives a **Writing Manual** which provides step by step guidance by suggesting reference materials and research and writing techniques. Students use a central resource center and university and industrial libraries.

Scientists and teachers review final research papers to offer comments and criticisms. In the past student research papers have been read by members of the New York Academy of Sciences, Bell Laboratories, the Department of Energy, the Environmental Protection Agency, the New York State Power Authority, the National Energy Foundation, the New York City Department of Health, New York University Medical Center, and a number of other private and public institutions.

After their research, the students write letters making recommendations to responsible parties in government, industry, or science.

LECTURES

Throughout the academic year, all CIIS participants meet to hear various lectures and discussions on the current theme of the program. Using outside experts as part of the research provides broad-based and varied perspectives on the issues. Carefully selected speakers present a balanced overview of the issue.

Many speakers are available from local colleges, universities, local industries, special interest organizations, local scientific institutions, and government agencies. These lecturers give one hour presentations to all students in the program followed by a thirty minute questions and answer period. The lectures are open to all students, parents, and community groups.

By selecting resource people who are directly involved in the issues under study, students hear divergent viewpoints of the scientific, industrial, and political community at large, and see an accurate picture of the opportunities and requirements needed in many different careers.

Some of the lectures have been:

- "Legal Aspects of the Disposal of Hazardous Waste: Implications for the Sciences"
  George Shanahan (Attorney, Law and Water Enforcement, EPA)
- "Education and Risk Assessment"
  Dr. William W. Lowrance (Stanford University)
- "Human Experimentation"
  Dr. Eugene A. Sersen (Institute for Basic Research)
- "Animal Experimentation and the Media"
  Dr. Ethel Tobak (American Museum of Natural History)
- "Morality and In Vitro Fertilization"
  Dr. Robert Benson (Wagner College)
- "The Art and Poetry of Biology and Blood"
  Dr. Leo Vroman (Interface Laboratory, Brooklyn Veterans Administration Hospital)

FORUM

The **Contemporary Issues In Science** program culminates in the Science Forum in which **CIIS** students share their ideas on the issues with academicians, scientists, business representatives, community members, parents, and other students in a full day forum.

The Science Forum translates the students research into a practical dialogue with the community. By being highly structured it involves all the **CIIS** students enabling them to use their research efforts.

Students moderate the program, participate in small group discussions, present abstracts of the issues involved, listen to the opinions and expertise of others, and make recommendations on the various issues. By student orientation, the Science Forum provides invaluable insight and experience in communicating with the community particularly when more schools participate.

EVALUATION

Questionnaires given to all **CIIS** participants and informal discussions following the conference in March 1978 showed a clear need to continue the activity in a more formalized program, include more schools in the conference, and involve more natural and social scientists in the schools as facilitators and mentors to support the student research. The evaluation also identified three benefits of the conference. The conference:

* Increased student-student and student-public interaction
* Increased student and public knowledge on scientific issues
* Pointed up the need to make the issues an integral part of the educational programs in the schools.

At the 1980 conference, responses from over 200 participants showed that:

* Student were well-informed on the issues under discussion
* Panel discussions were meaningful and helpful in clarifying the issues for both the students and the community
* Students benefited from the program through group discussion, the ideas and opinions of an open forum, the independent research, and the direct communication with scientists in the field.

In 1981 the National Science Foundation, recognizing the success and potential of **CIIS** awarded it a grant (SED 8113600) to support the program's continued development and dissemination of its efforts. By 1981, the program had grown from two schools to seven. In 1982, the city of Albuquerque, New Mexico adopted the **Contemporary Issues in Science** program and the number of participating schools jumped to 37!

The New York City Board of Education, the Staten Island Continuum of Education, and the New York Academy of Sciences gave support for **CIIS** from the start, and Wagner College has hosted **CIIS** inter-school activities and permitted students to use its research facilities. A resource center at the Staten Island Continuum has offered additional assistance to both students and teachers.

Public encouragement of the CIIS approach to learning has also come from the **New York Daily News**, the **Staten Island Advance**, the **Staten Island Register**, **SISTA Journal**, the **American Biology Teacher**, the **National Association of Secondary School Principals' Curriculum Report**, **Impact II**, **ChemEcology** (the Chemical Manufacturers' Association's publication), and the **Italian-American Institute to Foster Higher Education**.

In addition, certain colleges and universities which offer courses of study in science and technology, public policy and decision making have also given recognition to the importance of CIIS in preparation for advanced study.

CHARACTERISTICS FOR SUCCESS

The **Contemporary Issues in Science** program fills a major gap in science educationby providing a model involving real-world problem solving. The research papers, the lecture series, and the forum all emphasize student decision making.

The course provides the technical skills useful for understanding issues which stand at the interface of science and society. Citizens can no longer ignore the rapid technological advances that envelope every aspect of modern society. Science only becomes real and germaine to students with the opportunity to think and work rationally on issues affecting their lives. Social awareness must be an integral component in science teaching.

The **CIIS** program helps students undeterstand not only the content and process of science, but also its social ramifications through developing objective analysis, rational thought, and careful value judgements all of which contribute to informed decision making.

Through dialogue with people involved with these issues, students witness the wide variety of scientific careers available and gain an idea of the opportunities and requirements needed to pursue careers in the technological fields.

DEVELOPMENT

The First Year

The **Contemporary Issues In Science** began in 1976 when two New York City high school biology teachers, Vincent J. Cusimano from Susan E. Wagner High School and Stephen Halpern from New Dorp High School, saw the need for a science course which would transcend tradtitional curriculum limits, draw upon the resources of the community, and have viable meaning for the students. They gave each of the fifty Advanced Biology students from the two schools one of eight independent study topics for a research project including three biosocial issues. After completion of the research papers, the students from the two schools met in eight panels and discussed the issues during a three hour conference. Teachers and administrators were invited to attend the discussion groups. The success and sustained interest of the students in the biosocial issues suggested the need for making the conference a formal part of the Advanced Biology curriculum in the two schools. From this seminal experience evolved the interest, motivation, and involvement of the local educational and scientific community.

The Second Year

In September 1977, research guidelines prepared for students identified four contemporary issues recombinant DNA, euthanasia, transplantation, and population control, and local resource people. Students procedded on independent study receiving support materials and participating in small discussion groups. In March 1978, a joint three hour conference included student presentations of the papers on the four issues, panel discussion, and formulation of recommendations on each issue with educators as well as the community members participating in the discussion groups.

The Third Year

During the fall of 1978, a non-public school joined although not making the project a formal requirement within their curriculum. Their 16 students researched four topics as part of an independent study project including cloning, laetrile, in-vitro fertilization, and the media.

During the school year guest speakers from Wagner College, the New York State Institute for Basic Research, and the Brooklyn VA Hospital addressed the students of the three schools and a total of 60 students researched topics and prepared papers. In March 1979, at the Third Annual Science Forum held at Wagner College, students presented brief descriptions of each of the issues, held panel discussions, and made recommendations to the forum body. The group of 164 conference participants included student observers from other schools, school administrators, teachers, college professors, medical and scientific professionals, and community members.

The Fourth Year

In the fall of 1979, the New York Academy of Sciences assisted in the development of the program by providing assistance in deciding on four contemporary scientific issues for student research, providing transportation for students to attend lectures sponsored by the Section of Science and Public Policy, and beginning an Education Coordination Subcommittee for review of student papers by scientists, for planning lectures consistent with the four selected issues of research, and fro providing the expertise and direction necessary to further assist the program.

Also, in the fall of 1979, a fourth school which already featured independent research in their Advanced Placement Biology course joined the program, and all students received guideline booklets for conducting library research on human experimentation, nuclear energy, solid waste disposal, and carcinogens. Four lectures sponsored by Wagner College, the NYS Institute for Basic Research, and the New York Academy of Sciences explored the year's theme, "Risk/Benefit Assessment." Twenty-two scientists from the New York Academy of Sciences reviewed students' papers. Community input and further involvement provided through the formation of a Science Forum Coordination Committee represented diverse community groups. In April, the Fourth Annual Science Forum, held at Wagner College, featured 14 panels of scientists, teachers, students, and member of the community, and a format similar to the conference held in 1979.

The Fifth Year

For the 1980-81 theme, "Science and Technology: Government Regulation," the students from the four schools researched and prepared their papers in one of three areas: coal extraction and utilization; solar energy; recombinant DNA. Students prepared and attended a panel discussion of government regulation which drew over 150 students, parents, and educators. The New York Academy of Sciences, through the Section of Science and Public Policy, sponsored a lecture on Government Regulation for the students in the program, and one economics teacher worked with students in the program. This practical approach worked well within the normal curriculum organization and class structure of the schools.

The program has grown and business and industry have recognized its potential. Con Edison, Brooklyn Union Gas, the Power Authority of the State of New York (PASNY), and Monsanto have combined to help underwrite some of the continuing costs of the program.

Experience, observations, and data accumulated over the years have clearly defined program elements necessary to a formal program that readily adapts to varying district needs and which insures a broad national impact.

THE FUTURE

With the CIIS program now firmly established, the bright and challenging prospects for its growth and development suggest dreams of a program in each state enhancing the study of science and technology in our schools, encouraging youth to pursue carreers in fields of science and social issues, fostering the continued development of thinking young men and women of the future, and making this a better world for all humankind.

Neither time scheduling nor geography need limit a school's ability to present significant lectures to its students. Videotaping lectures from various fields increases the availability of divergent viewpoints on the critical issues of the day and the establishment of a videotape library and resource center permits schools, libraries, community groups, and industries throughout the United States and, in deed, throughout the world to benefit from viewing responsible representatives from all sides of the issues as they explain their positions.

As more and more school districts adopt the program, the creation of a National Science Forum comes closer. Convening in a major city, the National Science Forum could give students opportunities to exchange views and discuss recommendations with experts in science, industry, and government and provide students a forum for their ideas and research. Such a forum would increase public awareness of the issues and foster a greater understanding of the crucial risk/benefit assessments we must all face.

The technological capabilities already exist for a centralized student-run data base system geared to CIIS themes. Students can draw upon schools, industry, science, and government and feed abstracts of local, national and international articles into such a data base system which could disseminate this information throughout the world. Based on this model, the potential exists to expand the research skills of the average secondary school student through data base terminals in schools, libraries, and even in the home.

Sophisticated technologies demand communication exchange. Our world, as it becomes smaller, depends more and more interdependence. Understanding defenses, anger and hostility toward people and policies misundertood. The need to investigate and to study the issues that surround us continues to increase an importance in the years to come.

Ambitious plans such as these, require support and funding from the sciences, the government and private industries for lecture series, forum participation, student internship programs, publications, and resource materials.

Contemporary Issues in Science stresses that each of us shares the responsibility for the world we live in. By sharing what we know and helping today's young people to understand the multi-faceted issues of our times, we can combine to make a better world both now and for tomorrow.

Three manuals support the program: **The Writing Manual** (guides students through the research paper); **The Course Manual** (supplements a full scale elective course); and **The Implementation Manual** (describes various ways a CIIS program can be utilized and established).

The 100 page implementation manual for **Contemporary Issues in Science** gives a program overview, instructions for the research paper and class discussions, procedures for the lectures, and details the organization for the forum including preparation for the forum, student preparation, organizing the panels, and assigning roles.

The manual also describes the advisory group, resource center, paper reviews, community involvement, business education/industrial arts, internship/ career education, interdisciplinary approach and lists some issues. The five sections of the 140 pages course manual discuss source selection, student research tools, writing, case studies, and science, society, media.

Procedures in the writing manual explain for students how to research, the preliminary search, the preliminary biblography, outlining, locating references, abstracting and cataloguing references, citing references, writing style, revision and proofreading, and paper format. Also included in the 40 page manual is the research paper timetable.

PROBLEMS ADDRESSED BY THE PROGRAM

The National Assessment of Educational Progress (1978) showed a steady decline in secondary student enrollment in science courses over the past 10 years. Supported by evidence accumulated by the National Association of Biology Teachers, the National Science Teachers Association, and studies by the Biological Science Teachers Association and studies by the Bilogical Sciences Curriculum Study group, this decline can be attributed, in part, to the lack of relevance in the curriculum. Science only becomes real and germaine when students have the opportunity to think and work rationally with issues such as population, environmental quality, and genetic engineering in a context of social evolution.

The difficulty in meeting this need lies in the development of teaching strategies which allow students to examine their own beliefs and to make informed decisions on contemporary scientific issues in a down-to-earth and personally realistic framework. Although many programs exist on the college or university level, no comprehensive or widely successful strategy has been adequately translated into a viable and practical model for science education to the secondary level in the area of contemporary awareness.

In 1979 BSCS initiated a twenty-one month development and testing period of a new **Science, Technology** and **Society** program for 11th and 12th grade students. Although limited in scope, this is the only program on the secondary level that begins to address the need for curricula at the interface of science, technology, and society.

We complement this approach with emphasis upon direct contact with scientists in the field, availability of resource personnel with varied backgrounds, discussions with students from other schools and the community, and a flexibility in curriculum topics dictated by the contemporary nature of scientific issues in order to remove study from the constrictions of straight classroom instruction and foster student experience and well-informed decision making.

Chapter 10: EARTHSCOPE

By

Jim Black and Dave Brotherton

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Although the population of Huntsville grew from 16,400 in 1950 to 142,500 in 1980, growth has greatly slowed over the past ten years as a result of the space industry's slowdown. The U.S. Army's Redstone Arsenal and N.A.S.A.'s Marshall Space Flight Center made Huntsville a boom town in the middle of a leading cotton production center, and the cotton industry has taken a back seat to the space technology of the Saturn V development. The city covers over 114 square miles of fertile valley and mountain boardered on the south by the Tennessee River.

We house our Earthscope program, Huntsville City Schools' Environmental Educational Program, at Monte Sano Elementary School. This school, with 108 students and 13 teachers, sits on Monte Sano, a mountain on the eastern edge of Huntsville. The school grounds extend into Monte Sano State Park, a 2,140 acre forest with nature trails, camp sites, and an amphitheater.

We have two rooms in the school set up as an Environmental Center where we house a collection of mounted animals of North Alabama as well as equipment used for classes. In the wooded grounds behind the school we feature two outdoor classrooms with a seating capacity of about 35 students each and the state park planetarium we use in Earthscope.

The natural surroundings form the classrooms and we also have a recently developed center at Monte Sano which we use with the third grade classes. This all-weather center works with the planetarium, Burritt Museum, and the Environmental Center, all located on Monte Sano. We conduct the remaining classes at various sites throughout Huntsville.

OUR BEGINNINGS

In 1977 Dr. Don Tubbs joined Huntsville City Schools as Assistant Superintendent for Instruction. During a discussion, a local citizen, John Reynolds, mentioned reading an article in **Southern Living** concerning Fernbank Science Center in Atlanta. Dr. Tubbs expressed interest. The idea of starting a system-wide environmental education found tremendous local support, and the program started with a group of teachers who wanted to see it happen.

In the fall of 1977, we surveyed students, teachers, parents, administrators, and community leaders to determine the need for an environmental awareness program. The survey indicated an environmental awareness program would benefit the school curriculum. With the help of school administrators and local leaders, we then wrote and submitted a proposal for a federal grant.

In June of 1978, we received a $35,000 grant from the U.S. Office of Environmental Education to expand our program, to educate teachers, and to develop and test instructional modules for grades four through eight. From that time we have written numerous proposals and received money both federally and locally to continue the program. This crucial funding for our start-up program did not prevent us from continuing to change the program to better suit our needs. This grant primarily served secondary students and teachers training, but the following year we added the gifted and talented classes and upper elementary. Now, demand and staffing have reduced the scope of the program to the third and fourth grades.

We received initial stimulous from the Fernbank Science Center, but we also drew inspiration from Nashville's "Lib Roller," OBIS, Bill Hammond of Lee County Schools in Florida, the Boy Scouts of America, and of course from our own environmental staff.

Mary Anne Terry, a local teacher from Huntsville, did much of the ground work for developing the program and also directed the project for the first three years. For the last three years, we have developed the curriculum used in the classes with the assistance of many local resource persons.

Key to our program was the development of a curriculum for December, January, and February that could be used during inclement weather by using Wheeler Wildlife Refuge, Von Braun Astronomical Society Planetarium, and the newly established Monte Sano Environmental Center. Yet it was the grants received and funding available which guided the direction of the program more than any one key event.

We received particular support from the staff of Burritt Museum, Huntsville Transit Co., Monte Sano State Park, Von Braun Astronomical Society and Planetarium, University of Alabama in Huntsville - Johnson Environmental Center, NASA Public Relations (James Pruitt), Monte Sano Environmental Center, and of course, Dr. Don Tubbs, our Assistant Superintendent.

For the first three years of the program we wrote a curriculum guide which contained most of the activities used by participating classes including pre and post activities. The third and fourth grade Earthscope program now coordinates with the third and fourth grade science text, **Science - Understanding Your Environment** by Silver Burdett.

Teachers assisted in developing program activities through workshops in which they taught other teachers as if they were students. This eliminated activities that did not captivate the interest of the audience.

Due to the increased number of students we have scheduled over the past two years, some teachers cannot participate as often as in previous years. The attitude of most teachers has always been "we want more". However, we can only schedule classes two or possibly three times a year. The more involved the classroom teacher is, the higher the evaluation.

OUR PROGRAM

Earthscope, dependent originally on outside funding, now survives on local funds. And, while the environmental program has changed its scope due to funding, the core of the program remains the same. In the original program we included all grades in both city and private schools as well as eight teacher workshops per year, but now we serve only the third and fourth grades as a core group.

In our two regular classrooms, tables, each with two mounted specimens of North Alabama, allow students close contact with our wildlife. Shelves topped with reptile cages house snakes, lizards, spiders or many other live animals. The rooms also contain collections of tanned furs and skulls of numerous animals of the area, and display cases along the walls house a collection of latex casts of local snakes. As unique as our classes are, 90% of the time we use the community at large for our classrooms. We conduct classes in cemeteries, state parks, city parks, fields, along the Tennessee River, the water purification plants, and the sewage treatment plant.

Our goals feature the discovery and appreciation of the interrelationships of the systems of people and nature, and the involvement of individuals and groups in sharing an environmental caring. Three invariant program goals concern students' interest in environmental concepts, caring enough to communicate environmental concerns and interest, and enthusiasm to share the joy of discovery. Methods, however, change yearly as we update.

We teach various ways of preserving and using natural resources through a curriculum related to all forms of pollution (air, water, and land), energy related problems, and attitudinal problems about caring for the environment. We seldom give answers to students, rather we guide them into finding answers for themselves by presenting information, presenting a problem, and allowing them to decide for themselves. In this way, students must seek solutions to many real-life situations by exposure to scientific ideas. In most small group activities students work in groups of six to ten, arriving at group responses involving compromise. We work with about 60 students and 10 adults each session. Except for planning, students are actively involved in all aspects of the program and make recommendations and comments on their evaluation forms which are useful in improving following classes.

A typical week involves; Indian archeology studies, cemetery studies, plant and animal study at State Park and Burritt Museum, fossils, Planetarium, Environmental Education Center Curriculum, Water Purification and Sewage Treatment Plant, Johnson Environmental Center (Solar Energy), and exploration of various caves. We feel the most important magic is that moment when a student actually experiences, feels, and becomes excited about the direct hands-on learning experiences.

Teachers have broken away from a text-centered to an experience-centered teaching and are willing to allow students to find out from exposure rather than discussion or reading about the subject. Our hands-on approach uses the textbook only as a reference for base activities relating to text study material. The classroom teacher selects the topics for the class and our Earthscope staff develops activities for teaching the classes.

We guide discovery rather than using lecture or discussion. We act as companions to students by aiding the direction of discovery activities and guiding each student into a successful experience with the environment.

Classroom teachers plan thoroughly for pre and post activities because student benefit from an environmental education trip depends on organizational and pre-trip instruction and follow-up activities. An environmental teacher needs a basic knowledge of ecology and science but no concentration of knowledge is truly necessary. The important aspects of teacher love for the out-of-doors as conveyed through teaching skills requires teaching in less traditionally structured situations and non-conventional classrooms. We do anything from helping to identify a certain type of fossil to guiding a group of students through the cemetary with a compass.

For the two visits per year for every fourth grade class and one visit per year for every third grade class, the environmental staff carries out only a portion of the lesson on the day that the class particpates in the program. A lesson plan on fossils, for example, contains 12 pages listing the concepts, skills, and goals under study. It describes the settings for the activities and suggests some preliminary discussion material for the class, several task cards, and the pre and post tests. The bulk of the packet presents information on fossils. Teachers may select activities they want the environmental staff to use.

Our program is unique in that we do not plan the sequence of study. Teachers plan their participation in Project EARTHSCOPE based upon the course of study of their science and social studies book. For example, if a teacher plans to study Huntsville History in November, she will schedule her class for a culminating trip to Maple Hill Country. Thus, teachers plan their sequence of instruction around their trip rather than our staff planning it. We ask one parent to accompany the class on its trip for every six or seven students. Parents provide valuable assistance and actively participate in the program having as much fun, it not more, than the students involved. For all of this, program expenses are about one dollar per pupil per year.

Although our program requires few materials, with additional money we would invite various speakers and workshop coordinators to Huntsville. Every student, adult volunteer, and teacher participating in Project EARTHSCOPE evaluates our program. We provide master copies of the evaluation instruments so teachers may run them off and give them to the children and adult volunteers after the trip for completion and return to the Enviromental Center. Each year we receive thousands of evaluations from which we sample and compile evaluation results.

Teachers' positive assessment of Project EARTHSCOPE comes from their students' enthusiasm and enjoyment in the relaxed non-classroom atmosphere. Successful participation depends on pre-trip instruction for the class before the environmental experience. longitudinal studies would be most helpful to us since we are trying to shape attitudes more than anything else.

Professional organizations such as NSTA and NABT played no direct role in developing and maintaining the program as it exists today, but we have made presentations at the local Science Teachers Association. However, professional journals such as **Science and Children** and **The Science Teacher** (school subscriptions kept in the media center) provided many ideas we incorporated into the program.

While we need few changes in our existing activities and materials, we do need more activities dealing with some of Hunstville's important natural resources such as the Tennessee River. In addition, we need to build upon previous concepts with additional blocks of activities.

After four years of existance, we have the planning process for participating classes well in hand, although some details such as lunch preparation and collection of lunch money still require too much time.

Over the last four years we have had approximately 30 workshops for teachers in the program but, because of budget cuts, we will provide only one inservice workshop per year to serve the environmental education wants and needs of teachers.

We would like to solidify previous concepts and attitudes learned in the third and fourth grade by instituting a one week fifth grade camping program in the future. But, because of funding problems the program will stay basically the same. Also, the program has been extremely successful and many of the teachers don't want it to change.

Optimally, we should provide two hours a week for the entire school year for each class, but realistically, only 30 minutes a week for the entire school year are available for each class. Less time or the loss of one of us would cause the program to fail as would removal of hands-on, experiential learning type activities.

If you want to start your own Environmental Center:

1. Talk to school and local officials to determine the need for an environmental education program.

2. Obtain classroom and office space for operations.

3. Scout out the entire county, searching for resources that could serve as curriculum and classrooms for your students (fossil beds, rivers, archaeological dig areas, water purification plant, parks, cemeteries, etc.)

4. Next get logistics straight (buses, lunches, etc.).

5. Plan a curriculum based on a hands-on approach.

6. Formulate the preparation packet describing the program and distribute to teachers of the grade level you will teach.

7. Finally, begin the program. Each of these is an on-going operation and cannot be accomplished overnight.

SOME REWARDS

We are constantly rewarded by the excitement of children who are participating in fun, hands-on activities, while having the opportunity to work and teach in the out-of-doors rather than in the conventional classroom. We also have received several awards and recognitions. The Alabama Environmental Quality Association named us their outstanding educational program in the state three years in a row, and EQA named Mary Ann Terry Teacher of the Year. She also received the Trillion award from the Alabama Conservancy for outstanding teacher. Jim Black was National Teacher of the Year named by NACD's Allis Chalmers-Environmental Conservation Education Awards Program, and Dave Brotherton received the State Teacher of the Year award from the Alabama Wildlife Association.

As stated earlier, over the past 4 years Project EARTHSCOPE's 30 workshops have taught teachers how to incorporate environmental education into their curriculum and to supply them with the information to do so. Currently the workshops help teachers to incorporate environmental education into their curriculum but, unfortunately, only one teacher workshop a year can be offered in the future. While we are struggling to maintain ourselves, we can see we have made a significant impact.

Chapter 11: MARINE ENVIRONMENTAL PROGRAM

By

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Prior to my selection as science teacher, Quilcene offered no environmental education, and a strict disciplinary emphasis included few attempts to coordinate various academic areas in interpreting our own environment. The old approach provided a fragmented pattern of information for the learner, with few clues to the significant.

We wanted to develop a greater student awareness of environmental interrelationships from marine to alpine by developing a program to allow understanding across academic boundaries through environmental education classes. We focus on three levels: 1) first and second grade, 2) seventh grade Marine Environmental Science, and 3) ninth grade Environmental Science.

These three areas of concentration, important in the development of the K-12 curriculum, focus on faculty interest in the quality of the community's environment. For the first time we encourage students to gain a better understanding of their community as they become involved in activities which use their knowledge and awareness in other academic and non-academic areas. We encouraged all teachers to attend inservice and summer school to study environmental approaches in their specialization. This enabled teachers receiving students from the focus grades (1, 2, 7 and 9) to build on students' past learning experiences in specific academic disciplines.

OUR PROGRAM

Our 1972-73 environmental education workshop developed an awareness of the potential educational resources of the local environment outside of school, provided teachers with knowledge and confidence to use these resources and seek others, provided information required to develop task cards, and provided simulation games development material.

Our new science program objectives are:

* To provide each student with an opportunity to interrelate all learning areas in understanding our total environment;

* To provide an active outdoor program that stimulates student interest and encourages academic involvement;

* To develop in each student a respect for the unique environment around Quilcene and Brinnon;

* To prepare students to make intelligent decisions in matters that affect their local, national, and international environment;

* To promote and support more effective use of the unique marine to alpine environment of the Quilcene-Brinnon area by enriching and enhancing currently existing kindergarten through grade 12 programs with activities that use these areas.

At the core of our program is the relation of people's interdependence with both the natural and the human components of the environment. The Environmental Education program, an integral component of the curriculum, engages students in first-hand experiences having genuine meaning for them through the process of inquiry. We use the school, school grounds, and overall community as an environmental laboratory to incorporate concepts and processes, from the physical and social sciences, in understanding the environment and in developing values that will guide positive action.

For the first and second grade environmental classes we seek:

* To provide young students a chance to look at and study their whole environment in school;

* To encourage students to look at the world and the environment as a totality, not a collection of study areas;

* To provide students an exposure to environmental values which affect positively the well-being of the total environment;

* To provide students problem solving activities which develop reasoning powers and encourage individuality.

The 9th grade Environmental Education program, a model for the 7th through 12th grades, replaced the one semester class of General Science and focuses primarily on the local area by:

* Exposing students to environmental interrelationships through the use of problem solving activities;

* Developing student confidence and pride in problem solving abilities;

- Developing awareness of human impact on the environment
- Supporting student efforts to explore specific areas of the local environment of personal significance.

In class we discuss current topics of significance in the area of the environment and use individual student readings, student and teacher opinions, films, local actions, national and international actions, and speakers to bring forth ideas.

While we feel the 9th grade environmental class is a success in not only examining environmental differences and problems and in providing individualized instruction, we have had some difficulties. Some towns-people do not like students moving around the community during school hours. Others prefer a more traditional program. However, overall the program has been well accepted. One of our on-going projects for the past several years is re-forestation by planting Douglas Fir seedlings for the United States Forest Service and the Weyerhauser Corporation. This is an activity appreciated by many in the community.

Positive student response encouraged us to develop the Marine Science program. The facilities and the staff of the Marine Environmental Center in Poulsbo helped provide inservice training and assistance in the development of the curriculum. Parents also showed high interest in the prospect of such a class due primarily to the close proximity to Hood Canal and their economic dependence on it. The staff of the Marine Environmental Center helped develop a unique marine program for Quilcene featuring the marine resources of the Brinnon-Quilcene area. In the Marine Science course we attempt to:

- Provide an understanding of the energy cycle as it exists in our marine environment;
- Enable students to identify the marine plants and animals;
- Provide understanding of careers available in this area and the skills and education required.

The 7th grade marine environmental program has proven to be quite successful due to use of Quilcene Bay and through hands-on involvement.

Each year the National Fish Hatchery allows high school science students to take eggs from silver and king salmon and steelhead. The students fertilize the eggs and take them to the school where they are kept and raised from fall to late spring when the fingerlings are released into the Quilcene River. To many of the students and adults in the community fishing for salmon and steelhead is the ultimate in recreation. Because of this, students have a great deal of natural curiosity and interest in hearing about these fish. This has become a very successful part of the program. Several of the high school students have also been allowed to work with the United States Forest Service monitoring the water quality on the Big Quilcene River watershed. They take samples periodically for testing and report the results back to the Forest Service. This, too, relates well to our community. Obviously the local agencies, the State Department of Natural Resources, the United States Forest Service, and the the National Fish Hatchery, along with the Weyhauser Corporation, have played major roles in helping the science classes become a true partner in the study and encourage stewardship of our local environment.

EVALUATION

The success of our complete program is evidenced by the high scores recorded by students in the 1981 CTBS tests and interest in advanced classes during their Junior-Senior years. In 1981 the science scores for forty-two eight and tenth graders were:

29% of the students tested,
scored above 90 percentile (National).

71% of the students tested,
scored above 50 percentile (National).

5%, of the students tested
scored below the 25 percentile (National).

While we are a very small school, we feel we are doing very well. Several students have furthered their studies of the local environment during their junior and senior years. They have done independent science research projects in oceanography, ecology, local plant life, and energy alternatives, etc. Our faculty work closely with them and, as a result, our program is slowly evolving as needs, interests, and ideas change. And, the community continues to appreciate us.

Chapter 12: SCIENCE/TECHNOLOGY/SOCIETY: A CRITIQUE

By

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> The age of innocent faith in science and technology may be over...every major advance in the technological competence of man has enforced revolutionary changes in the economic and political structure of society.
>
> Barry Commoner

> The social problems raised by science must be faced and solved by the social sciences and the humanities.
>
> Harold Dodd

Science and technology are not identical; the first seeks new knowledge and the second manages and manipulates the physical environment. The movement towards a Science/Technology/Society curriculum recognizes that science is a purposeful activity leading to new knowledge and, ultimately, new technology, new problems, and new decisions. The new curricula of the last twenty-five years have been academically oriented, aiming at the scientifically able students. These curricula, while good, fail to meet the needs of the majority of our students. The STS movement in curriculum development puts science and technology into a realistic perspective; realistic in that it recognizes that science and technology are meaningful only within a societal framework.

While STS curricula are not new, there have been few serious attempts in the United States to develop such teaching materials. The careful analysis and suggestions made by Project Synthesis and summarized by E. Joseph Piel in Chapter One are a powerful first step towards developing STS curriculum materials in this country. Such developments usually arise in response to a local need. And, the ten programs described in this issue are excellent examples of local initiative in meeting STS needs and the needs of the majority of students.

Project Synthesis pointed out that STS focus areas include: Energy, Population, Human Engineering, Environmental Quality, Use of Natural Resources, National Defense and Space, Sociology of Science, and the Effects of Technological Development. In Chapter One, Piel describes these in some detail and suggests teaching strategies and activities which might lead to further understanding and awareness of these areas.

From his suggested activities, it is obvious that Piel and the Project Synthesis Researchers are seeking a role for students that may be considerably different than that found in traditional science classrooms. Looking at the approaches he suggests, it is hard to imagine students merely sitting, reading, writing, and listening. To complete the suggested activities we envision students doing many of the classical activities in the classroom but also getting outside of the classroom, observing, questioning, and testing in their own community. We see students surveying community members, resources, and ideas. Equally important, we see students taking those ideas, attempting to understand them and go beyond them. Finally, we hope students will make decisions about rational action and attempt to initiate that action.

While such learning activities may not meet our notion of the standard classroom environment, it does meet our image of how a successful adult functions in society. And, if that's how successful adults function, why not have high school students function in much the same way? If they did, students may not find school to be such an alien environment as the last two National Assessments have shown.

The ten programs described in this issue were not selected as perfect examples of the ideal STS curriculum; rather, they are examples of curricula using an STS theme successfully implemented in a local school setting. Recognize them as such learn from them, and improve on them. Then, and only then, will we have the evolution of new programs which will work in each and every community.

A BRIEF SUMMARY OF THE EXEMPLARS

Piel states that energy should be a major area of STS study. Three of the programs, **Energy and Us** (Chapter Five), **Solar Projects Class** (Chapter Three), and the **Wallingford Auditing Technical Team** (Chapter Seven) all focus on energy. And, each approach that energy focus in a very different way with very different results.

Energy and Us studies energy from many perspectives. Students examine the role of power plants and energy transformations in manufacturing and packaging, as well as in consumer consumption. These students study the natural resources of their area, including land use and governmental issues. They examine their own personal energy consumption in relation to what they learn about energy.

But, they go well beyond this by taking action on issues at the city, state, and national level. Students in this program have testified at senate hearings, provided input to the city council, and are viewed by their community as knowledgeable young citizens. Truly, this is a program which works and works well at educating citizens who can and will take an active role in the community.

From another perspective, the **Solar Project Class** has students designing and analyzing solar efficient homes. While many science programs would do similar activities, this program has gone a step further. By teaming with the home construction class of their high school, these students see their solar construction ideas put into place in a real home. From interior design to site placement these students recognize that their studies in the Solar Project Class are not just academic exercises but are meaningful, lasting, and fully capable of error. Their class is just not preparation for the real world, it is.

An after-school science program ultimately led to the **Wallingford Auditing Technical Team**. After hearing a guest lecture, these students learned how to do energy audits of buildings and, like many wild-eyed students, felt they ought to conduct an audit. With their teacher's help, they gained permission to audit the school buildings. This audit led to revelations, analysis, and many recommendations. In the true sense of an STS program these students took their recommendations to the school board. The school board, upon hearing the recommendations, appointed a janitor as a liaison person and helped them carry out some of their recommendations. At the end of one year the school district had saved an incredible $260,000 in energy costs as a result of the energy audits of these few students.

Now, fourteen of the students have passed the State Energy Auditor Certification test and are certified energy auditors in Connecticut. Their audits of public buildings have led to recommendations and action saving their community more that 400,000 gallons of fuel oil and three million kilowatt hours of electricity to date. They are in great demand as speakers about energy conservation and have obviously learned a great deal. These students are not just learning about energy, they are doing something about it.

Perhaps not as spectacular but equally as innovative and interesting is **Mankind: A Biological and Social View** (Chapter Six). This program, the natural outgrowth of two teachers' daily discussions, combines biology and anthropology into a course where man and animal are viewed in relation to society, culture, and environment. This issue-oriented course focuses on the human population, using many techniques and extensive readings. Students analyze their past, present, and future, developing scenarios for themselves, their community, and society.

In a similar fashion, **Contemporary Issues In Science** (Chapter Nine) has discussions, research, lectures, and a forum of issues. Dealing almost completely with science-related social issues, this course is designed to enrich existing courses or to be an elective in science or social studies. Students discuss contemporary issues, research ideas, and hear guest lecturers present a variety of topics. Truly unique to this program is a regularly scheduled forum where students share ideas with community members from business, academia, and the community in general. At this forum students not only share ideas but help brainstorm solutions to real world problems.

Both of these last two programs deal with human engineering: humans and their welfare are a key point of focus. As Piel suggested, these courses are for all students and are complete STS courses.

While the issue of environmental quality is apparent in every program, some, such as the **Marine Environmental Program** (Chapter Eleven), use environmental quality as the major theme. The **Marine Environmental Program** has students studying energy cycles in a marine environment. In this career-oriented program, students hatch fish eggs for release in local streams and monitor water quality for the forest service. Students are learning not only about the quality of their environment but they are learning ways to study that quality and ultimately change it. They no longer see the environment as someone else's problem, but as their own and one which has solutions.

Earthscope, in Chapter Ten, is an elementary program for third and fourth graders. Here students study ecology, animals and the natural resources of Alabama. Collaborating with the social studies class, students study archeology, cemeteries, and classical plant and animal life. In this non-text program students seek solutions to real world problems in small groups. Students are outside as well as in and are identifying problems in their own environment.

The **Environmental Science** program described in Chapter Four is an elective course where students examine, analyze, evaluate, and react to world problems of now and the future. Students develop alternative solutions to problems and examine career opportunities. Using both field and classroom study, students learn many classical notions of ecology, build nature trails, and understand their community better.

The **Science/Mathematics/Computer Magnet School** in San Diego (Chapter Eight) is an example of using technology in a classroom setting. Here, 620 students share thirty-two terminals and thirty microcomputers as tools in their math, science, language classes, and research. All seventh and eighth grade students take courses in math, science, and computers. And, calculator courses are required as well. In ninth grade, these students take an experimental design course preparing them for their two years of required science in high school. These students complete many simulations and learn the power of computers as tools for analysis, drill, and other problems in classroom settings. They are truly taking advantage of developing their understanding of technology within a school setting.

Chapter Two, **Unified Science Modules for High School,** is a most unique program. Taking advantage of modular scheduling, this two year required science offering has relegated all other science, including biology, to elective status. Team taught by eleven members of the science department representing all academic fields, this locally developed curriculum has a primary goal of developing scientific literacy. Students are expected to apply facts, theories, and laws in the context of solving problems, understanding what scientists believe and how they act, and understanding how science operates and interacts with society. In many ways, this program well exemplifies an STS curriculum. It is locally developed and includes STS materials and ideas which are locally relevant. Teachers in this program use many special publications and films while effectively integrating considerable material on career development.

Students are presented information in a large group session but have many opportunities in medium sized and small group to discuss, clarify, and draw conclusions. This program uses a wide range of materials for both formal and informal study. These have been evaluated very systematically, demonstrating that students learn as much as in a more traditional course but gain in several important areas, such as attitude. And, not only are these students learning about science but they are learning about the nature of science and how science operates in real-world settings. This is truly an exemplary program and one which is being adopted by many other secondary schools.

SOME FURTHER THOUGHTS

But, while we applaud these ten exemplary programs, programs exemplary in their commitment to meaningful curriculum development and their concern about the majority of students who are not going to become scientists, we feel they could have gone still further. In many cases these curricula are mere electives having impact on relatively small numbers of students. We would like to see STS ideas and materials in every science course, particularly those required of all students.

While all of these programs cause students to examine, study, and analyze recent scientific and technological developments, all too often that examination and analysis is done from a rather academic standpoint. Students study the ideas, research the facts, and draw conclusions. But, rarely do they go outside the classroom to survey community members and concerned citizens about issues affecting their lives and their environment. The final "S" in STS stands for society, a society which must be involved, considered, and listened to.

While one important recommendation of Project Synthesis was inclusion of career awareness and information, in most of these exemplary programs careers are only a superficial orientation. Perhaps more outside speakers need to be invited into the classrooms, particularly speakers representing careers which may be considered less technical and less scientific than those usually thought of as "science careers." Current events and human interest stories about people in STS careers should be visible. Students must recognize that this is not just a school program but a major part of life.

In some of the programs students are getting outside the classroom and are taking definitive action based on their learning. But, we suspect, this is all too rare. Students need to learn about the problems of real world decisions and action. For example, in Chapter Five, **Energy and Us,** the teachers describe an incident where students discover that a sewage treatment plant is overloaded and polluting the local river. The students' initial idea was to close down the sewage treatment plant. After much agonizing and analysis these students realized that this was not a feasible decision politically or humanistically although it was very feasible scientifically. They could not close homes and stop construction. Students came to realize that values, even values they didn't agree with, are an important part of decision making.

Last, and certainly not least in our minds, we sense that much of the teaching is relatively traditional. We feel strongly that relatively innovative teaching strategies will be most beneficial for these and other programs. In fact, without such innovative strategies, STS curricula may be just another set of readings which will be revised in a few years. These innovative teaching strategies must have teachers modelling the behavior they wish students to follow; must have teachers as models of active inquiry, and must have teachers who are learners along with their students.

If these programs are truly to grow and proliferate, inservice in teaching strategies as well as curriculum must be a serious part of each and every one of them. Developers of these programs must convince teachers to include STS offerings and STS teaching strategies in the University curriculum.

As Joe Piel suggested in Chaper One, newsletters and journals relating to STS must be produced and distributed, providing a communication network among teachers and developers of STS materials. When we have achieved these steps, then we might truly say that the age of Science/Technology/Society curriculum is here; an age of concern with students, citizens, and relevance. Such concern should lead to more meaningful school science experiences, action, and citizens with a better understanding of science and the scientific enterprise.